# SCIENCE ABSTRACTS.

## Section A.—PHYSICS.

**NOVEMBER 1914.**

# CONTENTS.

### GENERAL PHYSICS.

PAGE
1770. Pendulum of Constant Length and Variable Rate. *L. Laboccetta* ........... 617
1771. Large Measuring Machines ........... 617
1772. New Reference Mark in Stereo-comparator. *C. Pulfrich* ........... 617
1773. Reduction of Paris Wireless Time Signals. *R. A. Sampson* ........... 617
1774. Distribution of Time Signals. *P. Sève* ........... 618
1775. The Litre. *C. Lallemand* ........... 618
1776. A.E.F. Physical Units and Symbols ........... 618
1777. Stresses in a Plate near a Plugged Hole. *K. Suyehiro* ........... 618
1778. Poisson's Ratio for Vulcanised Rubber. *L. Bouchet* ........... 619
1779. Flow in Metals under Large Stresses. *E. N. da C. Andrade* ........... 619
1780. Flowing Pressure of Plastic Bodies. *N. S. Kurnakow & S. T. Žemčužny* 620
1781. Critical Loads for Long Struts. *L. Bairstow & E. W. Stedman* ........... 620
1782. Rupture Stresses in Beams. *A. R. Fulton* ........... 621
1783. Fatigue Limits under Alternating Stress Conditions. *C. E. Stromeyer* ... 621
1784. Mean Density of Fractured Rocks. *G. F. Becker* ........... 622
1785. Change of Density of Sulphur with Rupture. *A. F. Melcher* ........... 622
1786. Flow of Gases and Vapours from Nozzles. *H. Parenty* ........... 622
1787. Vortex Motion in a Perfect Fluid. *A. Gray* ........... 622
1788. Flow of Liquids. *P. Alibrandi* ........... 623
1789–1792. ........... 623
1793. Surface Tensions of Liquids. *A. Ferguson* ........... 623
1794. Isostasy in India. *W. Bowie* ........... 624

PAGE
1795. New Paths of Physical Knowledge. *M. Planck* .......... 624
1796. Does Matter displace Ether ? *C. V. Burton* .......... 625
1797. Relativity and the Ether. *L. Page* .......... 626
1798. Influence of Radiation on Formation of Cloud. *C. Braak* .......... 627
1799. Principia Atmospherica : Circulation of the Atmosphere. *W. N. Shaw* ... 627
1800. Transmission of Terrestrial Radiation by Atmosphere. *F. W. Very* ...... 628
1801. Weather-cycle Periodicities by Newcomb's Method. *A. Schuster* .......... 628
1802. Amounts of Nitric Acid in the Rainfall near Melbourne. *V. G. Anderson* 629
1803. Oscillations of Tank-water. *K. Honda & T. Matsushita* .......... 629
1804. Secondary Undulations of Canadian Tides. *K. Honda & W. B. Dawson* 630
1805. Recent Physical Investigations in the North Atlantic Ocean .......... 630
1806. Equatorial Acceleration of Solar Rotation. *G. Meslin* .......... 630
1807. Measurements of Solar Radiation. *L. Gorczynski* .......... 630
1808. Determination of the Solar Constant. *F. H. Bigelow* .......... 631
1809. Sky Polarisation and Solar Constant. *A. Boutaric* .......... 631
1810. Solar Spectrum and the Earth's Crust. *H. N. Russell* .......... 631
1811. Heat Radiation in Atmosphere of Mars. *M. Milankovitch* .......... 631
1812. Temperature of Planets. *F. Vercelli* .......... 631
1813. Statistics of Satellite Orbits. *J. Delauney* .......... 632
1814. Numbers of Stars in Different Latitudes. *S. Chapman & P. J. Melotte* ... 632
1815. Spectroscopic Binaries and Velocity of Light. *R. S. Capon* .......... 632
1816. Variable Star VV (17·1912) Aurigae. *H. G. S. Barrett* .......... 632
1817. Total Light of the Stars. *S. Chapman* .......... 632
1818. Constitution of Nebulae. *J. W. Nicholson* .......... 632
1819. Radial Velocity of Orion Nebula. *H. Bourget, H. Buisson, & C. Fabry*... 633
1820. Atomic Weight of Elements in Nebulae. *J. W. Nicholson* .......... 633

## LIGHT.

1821. Polarising Prisms for the Ultra-violet. *S. S. Richardson* .......... 634
1822. Measurement of Cloudiness. *W. Mecklenburg & S. Valentiner* .......... 634
1823. Reflection Photometer for Small Areas. *P. G. Nutting & L. A. Jones* ... 635
1824. Registering Microphotometer for Spectra. *A. S. King & P. P. Koch* ... 636
1825. Crystallography. *F. Canac* .......... 636
1826. Refractive Index and Density. *I[rene] M. Mathews* .......... 636
1827. Enclosed Cadmium Arc. *T. M. Lowry & H. H. Abram* .......... 636
1828. Rotatory Dispersion. *T. M. Lowry & T. W. Dickson* .......... 637
1829. Pressure Shift of Zinc Spectrum Lines. *V. F. Swaim* .......... 638
1830. Absorption Spectrum of Zinc-vapour. *J. C. McLennan* .......... 638
1831. Wave-lengths of Hydrogen Lines. *W. E. Curtis* .......... 639
1832. Atomic Structure and Helium Spectrum. *J. W. Nicholson* .......... 639
1833. Effect of Self-induction on the Nitrogen Bands. *E. P. Lewis* .......... 640
1834. Ultra-violet Spectrum of Neo-ytterbium. *J. Blumenfeld & G. Urbain* ... 640
1835. Spectrum of Elementary Silicon. *W. Crookes* .......... 641
1836. Red Lithium Line. *T. Takamine & K. Yamada* .......... 641

PAGE
1837. Spectroscopy of Secondary Röntgen Rays. *M. de Broglie* .................... 641
1838. Direct Analysis of Secondary Röntgen Rays. *M. de Broglie* .................. 642
1839. Anomalous Zeeman-effect in Satellites of Line λ4359. *H. Nagaoka & T. Takamine* ........ 642
1840. Reflection of X-rays by Crystals. *W. H. Bragg* .......................... 643
1841. Asymmetric Haloes with X-radiation. *W. F. D. Chambers & I. G. Rankin* 643
1842. Radiation accompanying Oxidation of Phosphorus. *A. Blanc* ............... 644
1843. Transmission of Hard X-rays. *J. Laub* .................................. 644
1844. Ionisation in a Closed Vessel. *E. v. Schweidler* ......................... 644

## HEAT.

1845. Dilation of Ferro-Nickels. *P. Chevenard* ................................ 645
1846. Heat Capacity of Metals at Low Temperatures. *E. H. Griffiths & E. Griffiths* ........ 645
1847. Formation of Dew and Hoar-frost. *A. Lo Surdo* .......................... 645
1848. Well-known Experiment in Regelation. *S. Suzuki* ........................ 645
1849. New Method for Determining Specific Heats of Liquids. *E. J. Hartung* 646
1850. Freezing-point of Benzene as Fixed Point. *T. W. Richards & J. W. Shipley* ........ 646
1851. High-temperature Measurements. *C. E. Mendenhall & W. E. Forsythe* 647
1852. Rapid Method of Measuring Partial Vapour Pressures. *M. A. Rosanoff, C. W. Bacon, & R. H. White* ........ 647
1853. Measurement of Vapour Pressures. *I. H. Derby, F. Daniels, F. C. Gutsche* 647
1854. Firing of Gases by Adiabatic Expansion. *H. B. Dixon, L. Bradshaw, & C. Campbell* ........ 648
1855. Firing of Gases by Adiabatic Compression. *H. B. Dixon & J. M. Crofts* 648
1856. Limits of Inflammability of Fire-damp. *F. Leprince-Ringuet* .............. 649
1857. Photography of Explosion-wave. *H. B. Dixon, C. Campbell, & W. E. Slater* ........ 649
1858. Molecular-rotation Energy. *E[va] v. Bahr* .............................. 650
1859. Relation of Liquid Cohesion to Permeability. *W. C. McC. Lewis* ......... 650

## ELECTRICITY AND MAGNETISM.

1860. Force on a Dielectric carrying Displacement Current. *R. H. Goddard* 651
1861. Effect of Magneton in Scattering α-Rays. *W. M. Hicks* .................. 651
1862. Thermomagnetic Effect. *H. Zahn* ........................................ 651
1863. Electrification at Liquid-gas Surfaces. *H. A. McTaggart* ................ 651
1864. Sources of Disturbance of Normal Potential Gradient. *W. A. D. Rudge* 652
1865. New Atmospheric-electric Instruments. *W. F. G. Swann* .................. 652
1866. Volume Charge due to Positive Ions. *W. Schottky* ........................ 653
1867. Electron Emission from Glowing Solids. *F. Horton* ...................... 653
1868. Emission of Ions by Non-radio-active Salts. *D. Pacini* .................. 655
1869. Conductivity of Salt Vapours. *S. J. Kalandyk* ........................... 655

PAGE
1870. Theory of Ionomagnetic Rotations. *A. Righi* ........ 655
1871. Photoelectric Photometry. *J. Elster & H. Geitel* ........ 655
1872. Secondary Radiation from Canal Rays. *J. Koenigsberger & A. Gallus* ... 656
1873. Action of a Wehnelt Kathode. *F. Horton* ........ 656
1874. Disintegration of the Aluminium Kathode. *L. L. Campbell* ........ 656
1875. A Wire and a Coaxial Cylinder. *J. S. Townsend* ........ 657
1876. Discharge of Electricity from Points. *P. J. Edmunds* ........ 657
1877. Distinction between Spark Discharge and Arc. *A. Occhialini* ........ 657
1878. Wave-length-sensibility Curves for Selenium. *F. C. Brown & L. P. Sieg* 658
1879. Properties of Selenium. *F. C. Brown* ........ 658
1880. Light-sensitiveness of Selenium. *Abonnenc* ........ 658
1881. Evidence for Electron Atmospheres. *F. F. Householder* ........ 659
1882. Electrical Conduction at High Temperatures. *E. F. Northrup* ........ 659
1883. Electrical Resistance of Pure Iron. *G. K. Burgess & I. N. Kellberg* ........ 659
1884. Contact p.d. of Distilled Metals. *A. L. Hughes* ........ 660
1885. Volta-effect. *J. Guyot* ........ 660
1886. Pyro-electricity and the Quanta-theory. *S. Boguslawski* ........ 660
1887. Mercury Rectifiers. *W. Jaeger* ........ 661
1888. Potassium Photoelectric Cells. *H. E. Ives* ........ 661
1889. Testing of Potentiometers. *F. Wenner & E. Weibel* ........ 661
1890. Primary Mercurial Resistance Standards. *J. Obata* ........ 661
1891. Preparation of Alloys for Magnetic Research. *J. de Freudenreich* ........ 662
1892. Magnetic Effects in Iron, Nickel, and Cobalt. *K. Honda* ........ 662
1893. Compensated Electromagnetic as Standard Field. *R. Beattie* ........ 662
1894. Magnetic Transformation and its Nomenclature. *K. Honda* ........ 663
1895. Susceptibility of the Binary Alloys. *K. Honda & T. Soné* ........ 663
1896. Thermomagnetic Property of Magnetite. *H. Takagi* ........ 663
1897. Thermomagnetic Properties of some Elements. *K. Honda & T. Soné* ... 663
1898. Magnetic Susceptibility of Solids and Sands. *H. Tagaki* ........ 664
1899. Susceptibility of Paramagnetic Substances. *W. H. Keesom* ........ 664
1900. Magnetic Study of Iron Sesquioxide. *R. Wallach* ........ 664
1901. Role of Valency in Diamagnetism. *P. Pascal* ........ 665
1902. New Method for Magnetic Determinations. *A. Schuster* ........ 665
1903. Moon's Influence on Terrestrial Magnetism. *S. Chapman* ........ 665
1904. The 27-day Period in Magnetic Phenomena. *C. Chree* ........ 666
1905. Time Measurements of Magnetic Disturbances. *C. Chree* ........ 666
1906. Visual Sensation caused by a Magnetic Field. *C. E. Magnusson & H. C. Stevens* ........ 667

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY

1907. Rate of Solution of Hydrogen by Palladium. *A. Holt* ........ 668
1908. Crystalline Structure of Copper. *W. L. Bragg* ........ 668
1909. Radio-active Elements. *F. H. Loring* ........ 668
1910. Interatomic Forces and Chemical Affinity. *J. J. Thomson* ........ 668

PAGE
1911. The Allotropy of Zinc. *E. Cohen & W. D. Helderman* ........ 670
1912. Formation of Neumann Lines. *Matweieff* ........ 670
1913. Microscopic Study of Electrolytic Iron. *O. W. Storey* ........ 670
1914. Velocity of Transformation of Steel on Heating. *A. Portevin* ........ 671
1915. Changes in Mild Steel during Annealing. *A. Stadeler* ........ 671
1916. Effect of Carbon, etc., on the Transformation of Iron. *R. Ruer & R. Klesper* ........ 672
1917. Hardness of Iron-Carbon Alloys. *R. Vondráček* ........ 672
1918. Structure of Electrolytic Copper. *O. Faust* ........ 673
1919. Copper in Steel: Influence on Corrosion. *D. M. Buck* ........ 674
1920. Precipitation of Metals by Yellow Phosphorus. *R. M. Bird & S. H. Diggs* ........ 674
1921. Conductivity of Bromine Solutions of Iodine. *W. A. Plotnikow & V. E. Rokotjan* ........ 675
1922. Influence of Current Frequency on Yield of Ozone. *N. Puschin & M. Kauchtschev* ........ 675
1923. Theory of Rotatory Power of Liquids. *A. Mazzucchelli* ........ 675
1924. Analysis of very Small Quantities of Gas. *P. A. Guye & F. E. E. Germann* 676
1925. Compressibilities of Solutions of Inorganic Salts. *W. Watson* ........ 676
1926–1927. ........ 676
1928. Ideal Diffusion Coefficient. *G. McP. Smith* ........ 676
1929. Negative Osmose. *F. E. Bartell* ........ 677
1930. Measurement of Coefficients of Adsorption. *J. Bancelin* ........ 677
1931. Electrical Conductivity of some Fused Salts. *P. Walden* ........ 677
1932. Dissociation of Hydrogen into Atoms. *I. Langmuir & G. M. J. Mackay* 678
1933. Conductance of Hydriodic Acid at 25°. *E. K. Strachan & V. G. Chu* ........ 679
1934. Osmotic Data in Relation to Combined Water. *W. R. Bousfield* ........ 679
1935. E.M.F. of Concentration Cells. *C. A. Kraus* ........ 679
1936. Potential of the Copper Electrode. *G. N. Lewis & W. N. Lacey* ........ 680
1937. Electrostenolysis. *H. N. Holmes* ........ 680

# AUTHORS' INDEX.

Abonnenc, 1880.
Abram, H. H., 1827.
Alibrandi, P., 1788.
Almansi, E., 1789, 1790.
Anderson, V. G., 1802.
Andrade, E. N. da C., 1779.
Bacon, C. W., 1852.
v. Bahr, E[va], 1858.
Bairstow, L., 1781.
Bancelin, J., 1930.
Barrett, H. G. S., 1816.
Bartell, F. E., 1929.
Beattie, R., 1893.
Becker, G. F., 1784.
Bigelow, F. H., 1808.
Bird, R. M., 1920.
Blanc, A., 1842.
Blumenfeld, J., 1834.
Boguslawski, S., 1886.
Bouchet, L., 1778.
Bourget, H., 1819.
Bousfield, W. R., 1934.
Boutaric, A., 1809.
Bowie, W., 1794.
Braak, C., 1798.
Bradshaw, L., 1854.
Bragg, W. H., 1840.
Bragg, W. L., 1908.
de Broglie, M., 1837, 1838.
Brown, F. C., 1878, 1879.
Buck, D. M., 1919.
Buisson, H., 1819.
Burgess, G. K., 1883.
Burton, C. V., 1796.
Campbell, C., 1854, 1857.
Campbell, L. L., 1874.
Canac, F., 1825.
Capon, R. S., 1815.
Chambers, W. F. D., 1841.
Chapman, S., 1814, 1817, 1903.
Chevenard, P., 1845.
Chree, C., 1904, 1905.
Chu, V. G., 1933.
Cohen, E., 1911.
Crofts, J. M., 1855.
Crookes, W., 1835.
Curtis, W. E., 1831.
Daniels, F., 1853.
Dawson, W. B., 1804.
Delauney, J., 1813.
Derby, I. H., 1853.
Dickson, T. W., 1828.
Diggs, S. H., 1920.
Dixon, H. B., 1854, 1855, 1857.
Edmunds, P. J., 1876.
Elster, J., 1871.
Fabry, C., 1819.

Faust, O., 1918.
Ferguson, A., 1793.
Forsythe, W. E., 1851.
de Freudenreich, J., 1891.
Fulton, A. R., 1782.
Gallus, A., 1872.
Geitel, H., 1871.
Germann, F. E. E., 1924.
Goddard, R. H., 1860.
Gorczynski, L., 1807
Gray, A., 1787.
Griffiths, E., 1846.
Griffiths, E. H., 1846.
Gutsche, F. C., 1853.
Guye, P. A., 1924.
Guyot, J., 1885.
Hartung, E. J., 1849.
Helderman, W. D., 1911.
Hicks, W. M., 1861.
Holmes, H. N., 1937.
Holt, A., 1907.
Honda, K., 1803, 1804, 1892, 1894, 1895, 1897.
Horton, F., 1867, 1873.
Householder, F. F., 1881.
Hughes, A. L., 1884.
Hulshof, H., 1927.
Ishiwara, J., 1792.
Ives, H. E., 1888.
Jaeger, W. J., 1887.
Jones, L. A., 1823.
Kalandyk, S. J., 1869.
Kauchtschev, M., 1922.
Keesom, W. H., 1899.
Kellberg, I. N., 1888.
King, A. S., 1824.
Kleeman, R. D., 1926.
Klesper, R., 1916.
Koch, P. P., 1824.
Koenigsberger, J., 1872.
Kraus, C. A., 1935.
Kurnakow, N. S., 1780.
Laboccetta, L., 1770.
Lacey, W. N., 1936.
Laub, J., 1843.
Lallemand, C., 1775.
Langmuir, I., 1932.
Leprince-Ringuet, F., 1856.
Lewis, E. P., 1833.
Lewis, G. N., 1936.
Lewis, W. C. McC., 1859.
Loring, F. H., 1909.
Lo Surdo, A., 1847.
Lowry, T. M., 1827, 1828.
Mackay, G. M. J., 1932.
McLennan, J. C., 1830.
McTaggart, H. A., 1863.
Magnusson, C. E., 1906.
Matthews, I[rene] M., 1826.
Matsushita, T., 1803.
Matweieff, 1912.
Mazzucchelli, A., 1923.
Mecklenburg, W., 1822.
Melcher, A. F., 1785.
Melotte, P. J., 1814.
Mendenhall, C. E., 1851.
Meslin, G., 1806.
Milankovitch, M., 1811.
Munari, C., 1791.
Nagaoka, H., 1899.
Nicholson, J. W., 1818 1820, 1832.
Northrup, E. F., 1882.
Nutting, P. G., 1823.
Obata, J., 1890.
Occhialini, A., 1877.
Pacini, D., 1868.
Page, L., 1797.
Parenty, H., 1786.
Pascal, P., 1901.
Planck, M., 1795.
Plotnikow, W. A., 1921.
Portevin, A., 1914.
Pulfrich, C., 1772.
Puschin, N., 1922.
Rankin, I. G., 1841.
Richards, T. W., 1850.
Richardson, S. S., 1821.
Righi, A., 1870.
Ringuet, Leprince-, F., 1856.
Rokotjan, V. E., 1921.
Rosanoff, M. A., 1852.
Rudge, W. A. D., 1864.
Ruer, R., 1916.
Russell, H. N., 1810.
Sampson, R. A., 1773.
Schottky, W., 1866.
Schuster, A., 1801, 1902.
v. Schweidler, E., 1844.
Sève, P., 1774.
Shaw, W. N., 1799.
Shipley, J. W., 1850.

Sieg, L. P., 1878.
Slater, W. E., 1857.
Smith, G. McP., 1928.
Soné, T., 1895, 1897.
Stadeler, A., 1915.
Stedman, E. W., 1781.
Stevens, H. C., 1906.
Storey, O. W., 1913.
Strachan, E. K., 1933.
Stromeyer, C. E., 1783.
Surdo, A. Lo, 1847.
Suzuki, S., 1848.
Suyehiro, K., 1777.
Swaim, V. F., 1829.
Swann, W. F. G., 1865.
Takagi, H., 1896, 1898.
Takamine, T., 1836, 1839.
Thomson, J. J., 1910.
Townsend, J. S., 1875.
Urbain, G., 1834.
Valentiner, S., 1822.
Vercelli, F., 1812.
Very, F. W., 1800.
Vondráček, R., 1917.
Walden, P., 1931.
Wallach, R., 1900.
Watson, W., 1925.
Weibel, E., 1889.
Wenner, F., 1889.
White, R. H., 1852.
Yamada, K., 1836.
Zahn, H., 1862.
Żemcżużny, S. T., 1780.

## ERRATA.

Abstract No. 1652, p. 571, line 5: *for* $L(k\sqrt{d^3/t})$, *read* $L,(k/d^3/t)$.
Abstract No. 1657, line 12: *for* $x$, *read* × (= multiplied by).

# SCIENCE ABSTRACTS.

## Section A.—PHYSICS.

---

**NOVEMBER 1914.**

---

## GENERAL PHYSICS.

**1770.** *Pendulum of Constant Length and Variable Rate.* **L. Laboccetta.** (N. Cimento, 7. Ser. 6. pp. 40–58, Jan., 1914.)—A disc or ring of mass M is supported by an axis passing normally to its plane through its centre of gravity. A body of mass $m$ is attached to its rim. The period of oscillation is then $2\pi\,[R(1+\mu)/g]^{1/2}$, where $\mu = M/m$. If another small body $m'$ is substituted for $m$, and $\mu' = M/m'$, the ratio of the periods is given by $t^2/t_1^2 = (1+\mu)/(1+\mu')$, and hence also the ratio of the masses $m$ and $m'$. The pendulum thus serves as a balance. E. E. F.

**1771.** *Large Measuring Machines constructed by Société Génevoise.* (Engineering, 98. pp. 828–826, Sept. 11, 1914.)—One of these is adapted to measure a gauge of even 8 m. long. One new feature in the machine is a rolling foot, allowing that change in temperature shall produce no strain along the length of the bed. The most accurate of the machines described measures to 1 micron. It has a peculiarity already described [see Abstract No. 797 (1914)], viz. the reference scale, instead of being fixed, is placed at the horizontal level of the micrometer screw and moves with it. The advantage here is that a cosine error (instead of as usual a sine error) is introduced. P. E. S.

**1772.** *New Reference Mark in Stereo-comparator.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 34. pp. 221–233, July, 1914.)—This mark has the form of a balloon with a point at its lower end. It swings freely in the air and in use is brought over or near the object sighted. It is more under control than the ordinary device. P. E. S.

**1773.** *Reduction of Paris Wireless Rhythmic Time Signals.* **R. A. Sampson.** (Roy. Astronom. Soc., M.N. 74. pp. 545–548, April, 1914.)—A suggestion is made for the use of all the sets of rhythmic time signals for the reduction of time observations, instead of the first and last only as proposed in the

Paris Circular. Examples are given of the extra check thus provided, and details given of actual time determinations showing the extreme value of these signals for delicate investigations. C. P. B.

1774. *Distribution of Time Signals.* **P. Sève.** (Comptes Rendus, 159. pp. 284–286, July 20, 1914.)—Describes an improvement on the alternate-current transmitter of angular displacements devised by Abraham [Abstract No. 586B (1911)]. The new device gives a powerful action on the receiving instrument, which does not react on the transmitter. As there are no breaks of circuit, there is little danger of failure, and the receiver, after any interruption, takes up the position of the transmitter automatically. The receiver is analogous to the alternate-current galvanometer devised by Franklin and Freudenberger [Abstract No. 492 (1907)]. It consists of two coils with horizontal axis and normal to each other, surrounding two soft-iron needles inclined at 45°. The two coils connect with the two secondaries of the transmitter, and the horizontal projections of the needles follow the resultant of the two alternating fields due to the coils. The apparatus is specially adapted to the controlling of clocks, and to transmission of time. E. E. F.

1775. *The Litre.* **C. Lallemand.** (Comptes Rendus, 158. pp. 1297–1301, May 11, 1914.)—Originally the word "litre" was simply a synonym for "cubic decimetre"; but in 1880 the International Commission of Weights and Measures defined the litre as the volume of a kilogramme of water. This has introduced a dualism which is troublesome. The kilogramme is too great to correspond to the mass of 1 cub. dm. of water at 4° C. and 76 cm. pressure, by (27 ± 1 or 2) mgm.; it corresponds to the mass of 1 cub. dm. of pure water at 4° C. and (117 ± 2) cm. Hg column. The author advocates a return to the original definition for almost all practical purposes; then those who wanted a litre representing the volume of 1 kilogramme of pure water at 4° C. and 76 cm. pressure could specify this as a "metrologic litre" and could say that the density of water at 4° C. and 76 cm. was not unity but 0·999 978. A. D.

1776. *A.E.F. Physical Units and Symbols.* (Deutsch. Phys. Gesell., Verh. 16. 4. pp. 170–179, Feb. 28, 1914.)—Weight a force, not a mass; product of mass into $g$. Density; mass-density or specific mass, mass per unit of volume, $= m/\mathrm{V}$; weight density or specific weight, units of weight per unit of volume, $= mg/\mathrm{V}$; density proper or density-ratio (sp. gr.), referred to standard substance, $= (m/\mathrm{V})/(m_0/\mathrm{V}_0)$ or $(mg/\mathrm{V})/(m_0 g/\mathrm{V}_0)$; mass-volume (specific volume), volume per unit of mass, $= \mathrm{V}/m$; weight-volume (specific weight-volume), volume per unit weight, $= \mathrm{V}/mg$. Symbols: Energy, W; period, T; frequency of cycle, $\omega$; frequency in alternating current, $f$; specific resistance, $\rho$; conductivity, G; electrostatic induction, D; dielectric constant, $\epsilon$; counter-inductivity, M; magnetic flux, $\Phi$. Unit of heat energy, the international kilojoule or kilowatt-hour, $= 0{\cdot}23865$ of a 15° C. kilogramme-calorie: 1 k.-cal. $= 4{\cdot}19$ kilojoules. A. D.

1777. *Stresses in a Plate near a Plugged Hole.* **K. Suyehiro.** (Engineering, 98. pp. 231–232, Aug. 14, 1914. Paper read before the Soc. of Mech. Engin., Japan, April, 1914.)—An extension of a previous paper on stresses in plates having discontinuities. By a mathematical investigation which cannot be usefully abstracted it is found that concentration of stress due to the presence of a hole may be reduced by filling the hole with a plug. The theoretical results represent well the general features of the stress distribution experimentally determined by Coker [see Abstracts Nos. 906 and 1778 (1913)]. **J. W. T. W.**

1778. *Poisson's Ratio for Vulcanised Rubber.* **L. Bouchet.** (Comptes Rendus, 159. pp. 470–472, Aug. 31, 1914.)—Describes a continuation of previous experiments [see Abstract No. 1377 (1914)] on the elasticity of rubber subjected to very small deformations. A disc of rubber was placed between two metal discs forming an electric condenser. The whole was immersed in a chamber filled with water and provided with a capillary so that any change in the volume of the rubber could be at once detected. On charging the condenser to a potential reaching 58·5 c.g.s. electrostatic units there was no measurable change of volume. This confirmed the result of the previous paper [*l.c.*] that for very small deformations the value of Poisson's ratio for rubber is 0·5. **J. W. T. W.**

1779. *Flow in Metals under Large Constant Stresses.* **E. N. da C. Andrade.** (Roy. Soc., Proc. Ser. A. 90. pp. 329–342, July 1, 1914.)—The author has continued the work described in Abstract No. 1669 (1910), with the object of determining if the empirical laws determined for lead were applicable to other metals, and also to investigate the effect of temperature on the flow. The metals investigated were lead, tin, iron, copper, mercury, a lead-tin alloy, brass, and German silver. It was found that, without exception, all the pure metals gave extension-time curves which closely correspond to the equation $l = l_0(1 + \beta t^{1/3})e^{kt}$, deviations of the calculated from the observed values never exceeding 2 per cent. In the equation $l_0$ represents the immediate length on loading, $\beta$ is a measure of that part of the flow whose rate decreases as the time increases, and $k$ measures the final or viscous flow. The values of these constants depend upon the temperature and at a given temperature with increasing stress, $\beta$ tends towards a constant value while $k$ increases at a rate which itself increases to a constant value. The main result of this part of the work shows that metals of widely different nature obey the same general laws of flow over a range of temperature. Small quantities of impurities do not affect the general type of extension-time curves. Duplex alloys show an anomalous behaviour. At a certain stage of the flow produced at certain temperatures the wire softens instead of showing the hardening which is common to the pure metals. At other temperatures, however, alloys were found to behave normally. By subjecting to a high preliminary stress either in tension or torsion wires can be put into a state in which they will flow viscously from the start of subsequently applied smaller stresses. Photomicrographs of strips of soft iron extended at different temperatures showed that slip-bands were formed with equal distinctness and frequency, regardless of whether the extension took several minutes or was produced immediately. On the basis of the co-existence of the crystalline and amorphous phases an explanation of these various phenomena has been worked out. When a wire is loaded, there is an immediate stretching owing to a slip between, and inside, favourably disposed crystals. An immediate redistribution of stress then takes place, with the result that other less favourably placed crystals begin to slip and give rise to the $\beta$ flow. There is a limit to the ultimate number of lamellæ which can be produced, corresponding to the production of elementary crystals. This is represented by the limit to which $\beta$ tends with increasing stress. If the amorphous material is capable of flow it gives rise to the viscous or $k$ flow. At low temperatures the amorphous phase is hard, but as the temperature rises it softens at a relatively greater rate than the crystalline material. There is obviously no limit to the viscous flow. F. C. A. H. L.

1780. *Flowing Pressure and Hardness of Plastic Bodies.* **N. S. Kurnakow** and **S. T. Żemcżużny.** (Rev. de la Soc. russe de Métall. 1. pp. 256–310, 1913. Rev. de Métallurgie, 11. pp. 881–888, June, 1914. Abstract.)—Plastic materials occupy an intermediate position between the solid and liquid states. Under slow deformation they resemble liquids of high viscosity, and under rapid deformation they resemble fragile elastic solids. There is in such materials an exact parallel between the hardness and the flowing pressure at constant velocity—a fact which has been established by determining the Brinell hardness and the pressure required to cause a certain definite rate of flow for 100 different materials. The pressure-time curves may be divided into four types which indicate that there is no sharp line of demarcation between plastic and fragile materials. Solids which appear to be fragile under rapid rates of flow can be made to act like plastic materials either by decreasing the rate of flow or by increasing the temperature. The study of the viscosity of several binary systems has also been undertaken and has led to the following conclusions:—(1) The formation of solid solutions is marked by an increase of the general hardness and the flowing pressure. (2) The variations in the hardness of a continuous series of solid solutions may be represented by a continuous curve showing a maximum. (3) The hardness of a simple mechanical mixture is a linear function of the composition. (4) In a solid solution the coefficient of hardness at a given temperature is greater than that of either of the components. (5) The hardness and electrical conductivity diagrams are just the reverse of each other (antibates): the five types of diagrams for hardness and electrical conductivity are illustrated. The degree of purity of metals may be estimated from a knowledge of the hardness or the flowing pressure, this method being more sensitive than that based upon a determination of the electrical conductivity. This is confirmed by the fact that while commercial lead has a flowing pressure of 8·5 to 12·4 kg./mm.$^2$, Kahlbaum's pure product has a flowing pressure of only 6·6 kg./mm.$^2$. The variations in the hardness in relation to the corresponding changes in the modulus of elasticity have been studied in the case of the copper-nickel alloys which form a continuous series of solid solutions. While the hardness shows a maximum at about 45 % Ni the modulus is a rectilinear function of the composition. The results of the authors' work indicate that the application of viscosimetry to the study of solids will show differences between the various states of matter which cannot be made evident by other methods. F. C. A. H. L.

1781. *Critical Loads for Long Struts of Varying Section.* **L. Bairstow** and **E. W. Stedman.** (Engineering, 98. pp. 403–404, Oct. 2, 1914. Communication from the National Physical Laboratory.)—Describes a new method for the practical determination of the critical loads of struts such as those used in aeroplane construction where the ends are generally tapered according to no definite law. Consider a strut symmetrical about its centre and of length $2l$. Then if $I_x$ is the least moment of inertia of the section of the strut at a distance $x$ from the end at which the assumed critical load W is applied, while E is the modulus of elasticity and $y$ the deflection at the point $x$, $-\mathrm{EI}_x(d^2y/dx^2) = \mathrm{W}y$. By a method of trial and error and successive approximation, curves are built up for $-d^2y/dx^2$, $dy/dx$ and $y$. The ordinate of the $dy/dx$ curve becomes zero when $x$ is greater or less than $l$ according as the assumed value of W is respectively below or above the true critical load. After two attempts a very close approximation to the value of W is reached. The stresses in the strut when failure occurs may be found from the usual formula $\mathrm{M/I} = f/b$, where $b$ is the distance of the outside fibres from the neutral axis and $f$ is the stress. Then $f = b\mathrm{M/I} = -\mathrm{E}b(d^2y/dx^2)$, *i.e.* $f$ is proportional to $b(d^2y/dx^2)$, and thus can be found from the curve for $d^2y/dx^2$, as soon as $b$ has been determined from the form of the section. By drawing a curve of distribution of stress, and employing, as before, a method of trial and error a form of strut with uniform resistance to bending may be arrived at. J. W. T. W.

1782. *Rupture Stresses in Beams and Crane Hooks.* **A. R. Fulton.** (Roy. Soc. Edinburgh, Trans. 50. 1. pp. 211–228, 1913–1914.)—In previous experiments [see Abstract No. 225B (1913)] on the failure of timber under stress it was found that when the fracture point was reached, either (1) the tension and compression areas of the stress diagram both assumed the limiting form of rectangles whose ordinates were respectively equal to the ultimate breaking stresses of the material in direct tension or compression; or (2) the cohesion between adjacent fibres measured from the neutral axis outwards was insufficient to withstand the shear induced by the resisting moment of the beam. The formulæ for the ultimate extreme fibre stresses in tension and compression ($t$ and $c$ respectively) deduced in the previous paper [*loc. cit.*] have now been verified by experiments on cast-iron beams. The theory, previously applied only to rectangular beams, has also been extended to include beams of any section, provided the ultimate distribution of stress may be assumed rectangular, and this assumption has been justified by experiments on 9 different forms of wrought-iron beams. The theory has been further applied to cases of non-axial loading, such as crane-hooks, the further conclusions, justified by experiment, being in this case (3) that, provided shear does not take place, the neutral axis moves always to the position which reduces the summation of the tensile and compressive stress areas, across a section, to the equilibrant of the external forces (in the case of a beam this reduces to zero; in that of a hook, at the principal section, to the suspended weight); and (4) that the total resisting moment of these stresses must be equal to the external bending moment as measured to the neutral axis at rupture point, but that these balancing moments do not differ materially from those measured to an axis obtained by dividing the sectional area into tensile and compressive stress areas which are in inverse proportion to the magnitude of their respective ultimate direct stresses. J. W. T. W.

1783. *Determination of Fatigue Limits under Alternating Stress Conditions.* **C. E. Stromeyer.** (Roy. Soc., Proc. Ser. A. 90. pp. 411–425, July 20, 1914.) —Reference is made to Wöhler's work on endurance of metals and to bending fatigue tests by Margetson. A special torsion fatigue-testing machine is described, in which the test-piece is surrounded by an india-rubber sleeve with inlet and outlet pipes cemented into it through which water is passed, these latter pipes containing sensitive mercury thermometers. By this means it is possible to determine the heat generated in the test-piece, precautions being taken by measurements at other points to determine the flow of heat from or to outside connections. Diagrams and tables of results are given for various classes of steel and some non-ferrous alloys. C. O. B.

1784. *Mean Density of Fractured Rocks.* **G. F. Becker.** (Washington Acad. Sci., Journ. 4. pp. 429–431, Sept., 1914.)—The author opines that since rupture may cause a change in density, fissures in rocks represent voids as the elasticity of volume for crystalline solids is held to be perfect. Now orogenic movements are accompanied by extensive and minute fissuring as well as by folding and distortion, and in many instances what at first sight resembles plastic folding or contortion turns out on close inspection to have resulted from the crushing of a bed or layer under confinement. An example of this is cited by the author in the Coast Ranges of California. The case of a brittle bed bent under confinement is discussed and applied to the Coast Ranges, where if the voids amount throughout to 5 % the elevation produced by these alone would average about 20,000 ft. Now 5 % is of the order of magnitude of the interstitial space in closely piled spheres of radius similar to that of the average fragment, so that the diminution of density due to crushing is of the order of magnitude requisite to account for the variations of topography in a sense compatible with isostasy. The author does not assert that the formation of voids explains orogeny, but deems it worthy of consideration in tectonic theory. H. H. Ho.

1785. *Change of Density of Sulphur with Rupture.* **A. F. Melcher.** (Washington Acad. Sci., Journ. 4. pp. 431–434, Sept., 1914.)—These determinations were undertaken in connection with Becker's work on the mean density of fractured rocks [see preceding Abstract]. Six trial specimens were prepared, brass tubes of two different lengths and three different diameters being filled with sulphur. After the density of the samples had been determined, they were bent as nearly into the form of a complete circle as could conveniently be done, and the new density measured. The preparation and filling of the tubes with sulphur—operations involving considerable difficulty—is described in detail. The data obtained, although not of the utmost precision, are close enough to show that there is a decrease in density due to the rupture of the order of magnitude of 0·0673, which is the square of 0·2595, or of the interstitial space in closely piled spheres of equal radius. This approximation is apparently due to the rounding-off of the edges and corners of the fragments formed at the inception of bending. The present experiments indicate that 6·73 % is the limiting value for sulphur subjected to shear under ordinary hydrostatic pressure. H. H. Ho.

1786. *Flow of Gases and Vapours from Nozzles.* **H. Parenty.** (Comptes Rendus, 158. pp. 1973–1977, June 29, 1914.)—Reverts to past work and history, and points out the inexactitude of the equation of St. Venant and Wantzel when the conditions are anything but steady and adiabatic. The fact that the coefficient of the jet may exceed unity is explained by the author as due to non-uniform conditions over a cross-section. The author supports his analysis by the experimental results of Rateau. H. S. R.

1787. *Vortex Motion in a Perfect Fluid.* **A. Gray.** (Phil. Mag. 28. pp. 1–12 and 13–18, July, 1914.)—The first of these Notes on Hydrodynamics, both of which are mathematical, is an improved presentation with new matter of results given in a former paper by the author [Roy. Soc. Edinburgh, Trans. 1908]. The second note is a direct and elementary demonstration of the validity of the value given, without proof, by Kelvin for the translational velocity of a vortex ring in an unlimited fluid, in a note appended to Tait's translation of v. Helmholtz's celebrated paper [Phil. Mag. 33. 4th Ser., 1867]. G. W. de T.

1788. *Flow of Liquids.* **P. Alibrandi.** (N. Cimento, 6. Ser. 6. pp. 228-248, Oct., 1913.)—Shows that the "adherence" of a liquid to a solid wall is strictly an impossibility unless there is a vertical component of the attractive force, which in general is negligible. But the displacement of the liquid along the wall may be so slow as to render the hypothesis of adherence a workable one. E. E. F.

1789. *Action between Bodies moving in a Liquid.* **E. Almansi.** (N. Cimento, 7. Ser. 6. pp. 144-158, March, 1914.)—Investigates in what cases a force between periodically moving bodies, or bodies periodically changing their shape or size, may be expected when the bodies are immersed in a liquid, without regard to the strength of the force. E. E. F.

1790. *Hydrodynamical Analogy of Gravitation.* **E. Almansi.** (Accad. Lincei, Atti, 23. pp. 287-291, March 1, 1914.)—Gives a more general mathematical treatment than that of C. A. Bjerknes and V. Bjerknes, and arrives at the conclusion that the attractional constant is inversely proportional to the square of the period of the alteration in form or position of a body immersed in a homogeneous liquid. E. E. F.

1791. *Kinematical Interpretation of the Relativity Principle.* **C. Munari.** (Accad. Lincei, Atti, 23. pp. 781-787, May 17, 1914.)—Bases the interpretation upon the sole kinematical condition that "a uniform rectilinear motion of velocity *c*, affected by the Lorentz transformation, is transformed into another uniform rectilinear motion of velocity *c*." E. E. F.

1792. *Relativity Theory.* **J. Ishiwara.** (Sci. Reports, Tôhoku Univ., Sendai, 2. No. 4. pp. 149-161, 1913.)—A descriptive and critical survey of the theory of relativity. E. H. B.

1793. *Surface Tensions of Liquids in Contact with Different Gases.* **A. Ferguson.** (Phil. Mag. 28. pp. 403-412, Sept., 1914.)—Apparently the only investigations on the effect of the nature of the superincumbent gas on the surface tension of a liquid are those of Forch and of Bönicke (Winkelmann, Handbuch der Physik, 2nd Edition, vol. i. p. 1173) made by the capillary-rise method. The latter not being an ideal method for the determination of capillary constants, the author has made use of Jaeger's method, in which the surface tension of the liquid is arrived at by observations of the max. pressure required to release a bubble of gas from the end of a vertical capillary tube plunged below the surface of the liquid; not only is this method more sensitive than the capillary tube method, but it is independent of a knowledge of the contact-angle between the liquid and the tube. The author has recently developed a formula expressing the surface tension in terms of certain easily observed quantities [see Abstract 1656 (1914)]. Carbon dioxide and air were the gases chosen, and measurements were made with benzene, turpentine, water, methyl and ethyl alcohols, chloroform, and ether. Two factors contribute to the total effect caused by the gas, namely, that actually due to the nature of the gas in contact with the liquid and that due to the solubility of the gas in the liquid; these two factors seem to be inseparable, but evidence exists which indicates that the former is the more important of the two.

The experimental results given below are in C.G.S. units, the mean value of the surface tension at a liquid-air surface being called T and that at a liquid-$CO_2$ surface at the same temperature, $T + \delta T$, so that $\delta T/T$ represents the effect of replacement of the air by $CO_2$ :—

| Substance. | Temp. | T (air). | $T + \delta T(CO_2)$. | $\delta T/T$. |
|---|---|---|---|---|
| Benzene ............... | 17° | 29·37 | 28·83 | — 0·0184 |
| Chloroform ......... | 17 | 27·79 | 27·22 | — 0·0205 |
| Water .................. | 15 | 73·88 | 73·04 | — 0·0114 |
| Methyl alcohol ...... | 17 | 23·33 | 22·97 | — 0·0154 |
| Ethyl alcohol ...... | 18 | 23·12 | 22·84 | — 0·0121 |
| Ether .................. | 15 | 17·88 | 17·65 | — 0·0129 |
| Turpentine ......... | 18 | 27·98 | 27·85 | — 0·0046 |

The value usually given for the surface tension between turpentine and air is 26·7 dynes per cm. at 18°. Assuming that this value is really $T \cos \theta$, $\theta$ being the angle of contact of turpentine with glass, it follows that $\cos \theta = 26{\cdot}7/27{\cdot}98 = 0{\cdot}9541$, so that $\theta = 17{\cdot}5°$, which agrees closely with the value obtained by Magie (Phil. Mag. p. 162, 1888), from measurements of the total depth of a large bubble of air imprisoned in the liquid under a convex lens.

T. H. P.

**1794.** *Isostasy in India.* **W. Bowie.** (Washington Acad. Sci., Journ. 4. pp. 245–249, May 19, 1914. Abstract of paper read before the Philosoph. Soc., Washington, April, 1914.)—Recent investigations by the United States Coast and Geodetic Survey indicate that for the total area of the country isostasy is practically perfect, while the gravity reductions show that areas of smaller extent are largely compensated. These points are only brought into prominence by the new Hayford method of reduction, and as this method is now being used in India and Italy a comparison of the results was made. An analysis is made of the results published for 14 gravity stations in India, all approximately in the same longitude, and extending from lat. + 28° 16′ to + 28° 19′. The values at the different stations vary in size and sign, and seem to indicate local rather than regional departures from the perfect isostatic state; but the data, though small in amount, show that isostasy may be nearly as perfect for large areas in India as in the United States.

C. P. B.

**1795.** *New Paths of Physical Knowledge.* **M. Planck.** (Phil. Mag. 28. pp. 60–71, July, 1914.)—The fundamental changes in the main structure of physical theories are essentially constructive—not destructive—leading to modification and amplification of existing theory by the old way—conflict between experimental fact and portions of hitherto accepted theory. Now, as before, the great physical principles still hold the field—*e.g.* The Conservation of Energy, The Conservation of Momentum, Least Action, The chief laws of Thermodynamics. But assumptions hitherto accepted almost without question are proving untenable, or at any rate doubtful, *e.g.* The Invariability of Chemical Atoms, The Mutual Independence of Space and Time, and

The Continuity of all Dynamical Effects. The fact of heat evolution by radium compounds placed the first in conflict with the Conservation of Energy, and the principle holds the field. If relativity be assumed to be experimentally established, the Mutual Independence of Space and Time comes into conflict with the so-called principle of the Constancy of the Velocity of Light established, by the electrodynamics of Maxwell and Lorentz. The latter has so far held the field, and it is not at all probable that any abandonment of that position will occur. The assumption of the Continuity of all Dynamical Effects had long been accepted as a basis for all physical theories, but is now found in direct conflict with the experimental facts which have given rise to the Quantum Hypothesis. The disintegration of the energy of motion of water waves by continuous diminution of amplitude does not proceed indefinitely, but finds a certain limit in the size of the atoms. The atoms hold the energy together, in a way, each atom representing a certain finite material quantum which can move only as a whole, and the larger the atoms the less can the total energy of motion be subdivided. This is quite in accordance with classical theory, but according to this the disintegration should proceed without limit in the case of the repeated reflection of light waves within a hollow enclosure—the infra-red and visible rays should gradually disappear and become converted ultimately into invisible ultra-violet or chemical rays. But of such a phenomenon no trace is discoverable in Nature. The conversion here also attains sooner or later a perfectly definite and assignable limit, and after that, the radiation conditions remain stable in every respect. The old theory proved untenable, but the principles of thermodynamics have shown themselves to be unshakable. The only solution of the riddle appears to be that, even in the case of the immaterial light and heat rays, certain processes must be at work which hold together the energy of radiation in definite finite quanta, and unite it the more strongly the shorter the waves, and the greater therefore the oscillation frequency. In what way we are to conceive the nature of merely dynamical quanta we cannot yet say for certain, but the hypothesis has certainly led to the idea that there are changes in nature which occur, not continuously, but explosively. Moreover, the Quantum Hypothesis affords solutions of still more recent discoveries which are in conflict with the classical theory, *e.g.* of the observed fact that to raise a piece of copper through one degree at — 250° C. requires only about one-thirtieth of the heat required to raise it through one degree at 0° C., and that if we took the original temperature of the copper still lower, the corresponding quantity of heat would turn out many times smaller, without any assignable limit. The Quantum Hypothesis has also led to the most important result that the forces controlling the thermal oscillations in a solid are of the same kind as those which control its elastic oscillations, enabling us to calculate the thermal energy of a monatomic substance at various temperatures from its elastic properties, a performance far beyond the reach of the classical theory. Puzzling though the nature of dynamical quanta may be, it is difficult to doubt their existence, in some form or other. For whatever we can measure must exist. G. W. DE T.

1796. *Does Matter displace Ether?* **C. V. Burton.** (Phil. Mag. 27. pp. 843–852, May, 1914.)—The author showed in a previous paper [Abstract No. 415 (1909)] that if the motion of matter through the ether involves displacement of the latter by the former, as in the case of a body moving in a fluid, then forces should be called into play between neutral bodies moving through the ether, unless their motion through the ether is simply a question of transference, and involves nothing of the nature of a gross bodily displacement. It is here shown that if there be finite displacement, a flat plate moving uniformly in a constant direction through the ether would tend to set itself with its plane perpendicular to that direction, being acted on by a couple whenever its normal was oblique to the line of motion. A convenient way to test the existence of such displacement is, therefore, to suspend such a plate by a fine fibre so that its plane is vertical, and to watch for any changes of azimuth which may occur as the earth's rotation causes the suspended system to be presented in varying aspects to the earth's line of motion. Very delicate apparatus was constructed, and is described in detail, consisting essentially of a thin iridio-platinum plate with a bi-filar quartz fibre suspension, having an optical system of extreme delicacy for observations of any motions in azimuth, and provided with elaborate protection against the various possible disturbing effects. Semi-diurnal and diurnal terms occur in the expression for the amplitude, from which the corresponding amplitudes of the semi-diurnal and diurnal turning moments about the vertical axis are obtained, and limits can be named which these certainly did not exceed with the apparatus used, on the least favourable assumptions as to the sun's unknown motion through the ether. No positive results were observed, and the determined limiting values of the possible turning moment therefore lead to a maximum possible value for the displacement if it exists. Taking Lodge's estimate of $10^{12}$ gm. per cm.$^3$ as the minimum density of the ether, it follows that 1 gm. of matter occupies numerically less than $\pm 8{\cdot}1 \times 18^{-17}$ cm.$^3$, and probably less than $\pm 10^{-17}$ cm.$^3$. The double sign signifies the consideration of the possibility that the density of the ether might conceivably be either diminished or increased by the presence of matter. The conclusion may also be expressed in the form that the displacement must certainly be less, probably much less, than what we designate the "bulk" of the electrons. G. W. DE T.

**1797.** *Relativity and the Ether.* **L. Page.** (Amer. Journ. Sci. 38. pp. 169–187, Aug., 1914.)—The author's aim is to show that all electrodynamic phenomena—those relating to accelerated charges as well as those involving charges moving with constant velocity—may be expressed in terms of an ether consistent with the Principle of Relativity, and as necessary consequences of the postulate of the relativity of all systems which are moving with constant velocities. An expression is also derived for the electromagnetic mass of an electron whose field is not quasi-stationary, as in the case of Abraham's, Bucherer's and Lorentz's electrons.

The Lorentz-Einstein group of homogeneous linear transformations, as the mathematical formulation of the Principle of Relativity, is taken as the starting-point. An absolutely homogeneous ether satisfies the principle, but non-homogeneities are necessarily involved in interactions of material particles. And the ether will still satisfy the Principle if all such non-homogeneities are transmitted with the velocity of light, this velocity being an invariant of the transformations. Let these non-homogeneities, which may be called strains, be completely representable by a single-valued vector function E of position in space, having the properties that at any point the product of the volume element $d\tau$ and the divergence of E must be proportional to the charge in $d\tau$, and that the charge must be an invariant for the fundamental transformations. Then Div E will be zero in ether devoid of matter, and every charged particle will be a continuously-emitting source of strains. One further assumption, suggested by symmetry, is found to be necessary, viz. to an observer to whom the charged particle is, instantaneously, at rest the strains must be emitted uniformly in all directions. The number of assumptions is here reduced to half the number involved in Lorentz's equations of electro-dynamics. The strains are represented geometrically by means of tubes of strain. Considering first a charge permanently at rest relative to the observer, which will now be regarded as a continuously-emitting source of strains moving outward through the ether with the velocity of light instead of, as in former theories, being surrounded by a uniformly diverging field of stationary strains. But the direction of motion being always parallel to the strain, the number of tubes of strain per unit cross-section will be constant, as in former theories, and the energy density at any point, if varying as the square of the strain, will remain constant. The total energy of the field will therefore be finite, and it becomes obvious that emission of strain does not necessarily involve emission of energy. The effect of a moving charged particle is first discussed, using Gibbs's vector notation. The ether strain equations are obtained first for a single charged particle, and the general equations are then derived by the considerations that the total ether strain is the vector sum of the strains due to all the particles whose fields extend to the point in question. An expression is obtained for the mass of an electron which has had a constant acceleration relative to its own system for an infinite time. In conclusion, the author points out that his method of finding the retarding force due to the electron's own field does not explain, any more than Lorentz's original treatment did, why the mutual repulsion of the parts of the electron does not cause it to explode. [See Abstract No. 1896 (1912) and G. A. Schott, "Electromagnetic Radiation," p. 262 *et seq.*] G. W. DE T.

1798. *Influence of Radiation on the Formation of Cloud.* **C. Braak.** (Meteorolog. Zeitschr. 31. pp. 275–279, June, 1914.)—When a cloud is cooled by radiation more rapidly than the surrounding air, it will sink by reason of its increased density. If the normal rate of decrease of temperature with height prevails, this sinking will cause the cloud to evaporate on account of the dynamical warming produced. It is only when the rate of fall of temperature is very slight, or when a reversal occurs, that the initial cooling is followed by further formation of cloud. If, on the other hand, the cloud is absorbing radiation instead of emitting it, the opposite results hold—namely, that if the fall of temperature with height is normal, the rising of the cloud consequent upon its warming will cause further cloud to be formed. The gradient of temperature must either be very small or reversed if the warming eventually results in the evaporation of the cloud. In the paper the above statements are proved, and the critical small temperature gradient referred to is shown to be about 0·18° C. per 100 m. Instances of the application of the general result are given from observations made in Batavia during anticyclonic weather. R. C.

1799. *Principia Atmospherica: a Study of the Circulation of the Atmosphere.* **W. N. Shaw.** (Roy. Soc. Edinburgh, Proc. 34. pp. 77–112, 1913–1914.)—The author arranges our knowledge of meteorology, particularly that part of it relating to the upper air, in logical form with axioms, postulates, and propositions. Five axioms, or laws, of atmospheric motion are put forward, followed by two lemmas, or postulates, and six propositions. The whole argument is based fundamentally on the first axiom, which states that in the upper air the true wind and the "gradient" wind are identical; that is, the upper wind blows along the horizontal sections of the isobaric surfaces, and the velocity is inversely proportional to the distance between consecutive isobaric lines. The two lemmas contain statements of facts which have been established in recent years by upper-air research. The chief part of the paper is devoted to consideration of the propositions. In proposition 1 it is pointed out that while a steady uniform E. or W. wind covering a large area represents a stable condition in the atmosphere this is not so in the case of N. or S. winds. It is found by calculation that a south wind will tend to increase in vertical thickness as the air passes northward, and steady conditions over a large area require that a certain quantity of excess air should pass out sideways in the lowest kilometre layer of the current. This condition can be fulfilled in practice, and hence there is no insuperable difficulty in accounting for a persistent south to north current. The converse case of north to south wind requires a more complicated system of currents to allow of a steady persistent state, and it is concluded that the maintenance of a northerly current must be regarded as exceptional. Attention is specially directed to the conclusion to which this reasoning leads: That a steady state of persistent motion in the earth's atmosphere is in the highest degree improbable, because it can only occur in a combination of circumstances which are independently fortuitous. The next most important proposition is that which deals with the calculation of the horizontal temperature gradient which must exist in different levels to account for the changes in wind velocity from kilometre to kilometre found by pilot balloon ascents. The formulæ here worked out are applied to several typical cases. The last of the six propositions deals, in a more general manner, with the general circulation of the atmosphere over the northern hemisphere. J. S. Di.

1800. *The Transmission of Terrestrial Radiation by the Earth's Atmosphere in Summer and in Winter.* **F. W. Very.** (Science, 40. pp. 417–424, Sept. 18, 1914.)—The method employed to determine the percentage transmission of terrestrial radiation through the atmosphere consisted in comparing the actual radiation from a surface at the earth's temperature toward the sky with that toward a black body the temperature of which could be varied. By this means it was found that the radiation from a surface at + 18° C. (summer earth temperature) to the sky overhead was, with a clear sky, the same as to an efficient radiator at − 8° C. This − 8° C. is termed the "Effective temperature of the zenithal sky" under the conditions named. Taking these figures it is determined that the outward *unabsorbed* terrestrial radiation amounted to 0·57 gm.-cal. per sq. cm. per min. and the earth's radiation *to free space* to 0·15 gm.-cal. This gives a transmission of 26% for summer. In the same way a transmission of 58% is found for a clear winter day, when the air is more free from dust than in the summer. A. Ångström has found 0·15 gm.-cal. for an average value of the earth's radiation, which agrees with the above summer value. Lowell, on the other hand, who determined the transmission from consideration of the nocturnal cooling of the earth's surface with clear and cloudy skies, found a value some 50% larger than that determined by the present method. A suggested explanation of this discrepancy is put forward. J. S. Di.

1801. *Weather-cycle Periodicities by Newcomb's Method.* **A. Schuster.** (Roy. Soc., Proc. Ser. A. 90. pp. 349–355, July 1, 1914.)—The author discusses the analytical method devised by Newcomb for the investigation of periodicities, which was intended to give more complete values than the usual Fourier's analysis. A particular case is given in illustration, the data examined being the meteorological records collected by Brückner. The main conclusions are (1) that Newcomb's method is only applicable to special cases, the results obtained being in general difficult to interpret. (2) When it is applied to the 35-year Brückner cycle it does not lend any support to the reality of that cycle, although it seems specially adapted to deal with that type of periodic fluctuation. C. P. B.

1802. *Influence of Weather Conditions upon the Amounts of Nitric Acid and of Nitrous Acid in the Rainfall near Melbourne, Australia.* **V. G. Anderson.** (Chem. News, 110. p. 127, Sept. 11, 1914. Paper read before the British Assoc., Australia Meeting, 1914.)—Daily observations of the amounts of nitric acid and of nitrous acid in the rainfall have been made for over a year at Canterbury, near Melbourne. The concentration of nitric acid reached a maximum in summer and of nitrous acid in winter. The ratio of nitric nitrogen to nitrous nitrogen was highest in summer and lowest in winter. On many occasions in winter the ratio was approximately as 1 : 1. It appears that in rain-water nitric and nitrous acids are formed in equal molecular proportions. In the hot weather of summer the nitrous acid is rapidly converted into nitric, whereas in winter the conversion goes on less rapidly. The facts point to atmospheric nitrogen peroxide as the source of nitric and nitrous acids in rain water. It is found that the amount of oxidised nitrogen per acre carried down by rain falling on any day is a function of the type of weather, but within certain limits is independent of the amount of rainfall. These facts may be explained by assuming that for each type of weather there exists in the air a definite concentration of nitrogen peroxide, and that this soluble gas is completely washed out of the air by the first portions of a shower. J. S. Di.

1803. *Investigation of the Oscillations of Tank-water.* **K. Honda and T. Matsushita.** (Sci. Reports, Tôhoku Univ., Sendai, 2. No. 3. pp. 131–148, 1913.)—The paper contains an investigation of stream lines in flowing water by means of Honda and Terada's photographic method for studying the oscillations in the model of a bay. The method consists in scattering a fine aluminium powder over the model, and taking photographs of the oscillating water by exposing the dry-plate about one complete period of oscillation. After development, the stream lines are seen in the loop of the horizontal motion, while in its node the powder appears in points, so that the actual mode of oscillation of water in the tank can be perceived from the photographic plate. A square, a circular, an annular, and an equilateral triangular tank were studied, these being of zinc and placed on a board resting on stout india-rubber tubes to admit of easy oscillations. The oscillation was generally excited by a vertical rod, fixed at its lower end to the tank and carrying a weight which could be adjusted to a suitable height for varying the oscillation period. To maintain the rod's vibration, a piece of soft iron was attached to its lower part, and an electromagnet placed near it. An electric circuit including the electromagnet was so arranged that it was closed once during every rod vibration. If the period of the rod approaches to that of the water in the tank, the amplitude of oscillation of the water is greatly increased, a beat of oscillation being observed for approximate coincidence and a prolonged energetic one for exact. The period of free oscillations, after the oscillating cause was withdrawn, was observed by means of a stop-watch, taking the mean of 10 sets of about 50 complete oscillations. In the case of the circular and annular tanks, a symmetrical mode of oscillation was excited by means of a lever, by applying a periodic motion to the centre of the base from beneath. The hydrodynamical solutions of these various tank-motions are briefly summarised, and tables of calculated and observed periods given. No less than 44 admirable photographs are included. H. H. Ho.

1804. *Secondary Undulations of the Canadian Tides.* **K. Honda** and **W. B. Dawson.** (Sci. Reports, Tôhoku Univ., Sendai, 1. No. 1. pp. 61–66, 1912.)—Six years ago, Honda with others investigated the secondary undulations of the oceanic tides on the coasts of Japan [see Abstract No. 400 (1908)], and found that the regular and conspicuous undulation in any bay is generally the standing oscillation having the node of its vertical motion at the mouth of the bay and its loop at the head. The period T of such an oscillation is fairly given by $T = 4l/\sqrt{gh}$, where $h$ is the mean depth, and $l$ the length of the bay measured normally to the contour lines of its bed. In an elongated bay there may exist the oscillation with 2, 3, 4, . . . nodal lines, and also in a few cases lateral oscillation in the bay. The exciting waves seem to originate in the open ocean, where wide undulations of various periods must apparently exist. From these the bay selects an undulation of the period which corresponds with its own dimensions in accordance with the above formula. The present paper refers to the undulations recorded on mareograms from five bays on the coasts of Canada: Sidney, Trepassey, Port aux Basque, Halifax, and SW. Point (Anticosti), all of which show conspicuous secondary undulations. The data obtained confirm the above views regarding the secondary undulations of the oceanic tide. These undulations are much accentuated in stormy and broken weather, showing apparently that the oceanic undulations from which they are propagated are probably due originally to meteorological causes. The Canadian observations also show that these secondary undulations disappear in long estuaries such as the St. Lawrence, analogous to the breaking up of the ocean swell under similar conditions. H. H. Ho.

1805. *Recent Physical Investigations in the North Atlantic Ocean.* (Nature, 93. pp. 541–543, July 23, 1914.)—This article is a review mainly of F. Nansen's investigations of 1910 as detailed in his oceanographical work entitled "The Waters of the North-eastern North Atlantic." L. H. W.

1806. *Equatorial Acceleration of Solar Rotation.* **G. Meslin.** (Comptes Rendus, 158. pp. 1560–1562, June 2, 1914.)—The author disagrees with the interpretation of certain of the conclusions formulated by Cornu concerning the peculiarities shown by spectrum lines when the spectroscope slit is adjusted at various angles on the sun's disc. The fact that the rotational velocity rapidly varies with the distance from the equator is regarded as sufficient to produce certain of the phenomena seen as distortions of the spectrum lines. C. P. B.

1807. *Measurements of Solar Radiation.* **L. Gorczynski.** (Nature, 93. pp. 362–363, June 4, 1914.)—The paper is a short review of observations made during the thirteen years 1901–1913 at Warsaw, using actinometers and pyrheliometers. They have an interesting bearing on the peculiar variations of the solar radiation during 1912, which have been ascribed to the effect of volcanic dust from the eruption of Mt. Katmai, in Alaska, at the end of June, 1912. For the earlier months of 1912 the radiation was higher than the average, but from July to the end of the year it was nearly 20 % below the average. The deficiency apparently disappeared in the second quarter of 1913. The results of the inquiry are discussed very fully with respect to different altitudes of the sun, times of day, and different conditions of the atmosphere, especially as regards humidity. C. P. B.

1808. *Determination of the Solar Constant by means of Computations based upon the data of Balloon Ascents.* **F. H. Bigelow.** (Amer. Journ. Sci. 38. pp. 277–281, Sept., 1914.)—The value of the solar constant, as derived from pyrheliometer observations, is about 2 gm.-cals./cm.$^2$ min. Abbot's observations on the spectrum energy curve are, however, best satisfied by an initial effective temperature of the sun of about 6900°, which leads to a value of 4 gm.-cals./cm.$^2$ min. for the solar constant at the distance of the earth. The author, using temperature and pressure observations up to 25 to 30 km., comes to the conclusion that the true solar constant (A) is 4, and that the "effective radiation" (I), measured by a pyrheliometer is A—J—B; where J is the radiation emitted from the earth's surface, while B is the "return radiation," and is equal to I during steady temperatures. J varies from about 1·5 at the surface to zero at 40,000 metres, and for steady temperatures $I = \frac{1}{2}(A-J)$, which is 1·25 at the surface and 2 above 40 km. At night, $I = B = A = 0$, and the nocturnal radiation proceeds from J only. R. C.

1809. *Sky Polarisation and Solar Constant.* **A. Boutaric.** (Comptes Rendus, 158. pp. 1600–1602, June 2, 1914.)—An investigation was made to determine the effect of polarisation of the diffuse light of the sky on the values obtained for the solar constant. It is shown that for groups of neighbouring days, the value of the solar constant varies inversely as the sky polarisation. C. P. B.

1810. *Solar Spectrum and the Earth's Crust.* **H. N. Russell.** (Science, 39. pp. 791–794, May 29, 1914.)—A comparison is given of the list supplied by Rowland showing the chemical elements represented in the Fraunhofer solar spectrum, and the table of Clarke showing the percentage composition of the outer 10 miles of the earth's crust, including the lithosphere, hydrosphere, and atmosphere. The average composition of stony meteorites is also added. The lists are very similar. One of the interesting differences is in the case of potassium, which is very abundant in the earth's crust, but there is some doubt as to its presence in the sun. C. P. B.

1811. *Variation of Heat Radiation in Atmosphere of Mars.* **M. Milankovitch.** (Ann. d. Physik, 44. 3. pp. 465–476, May 26, 1914.)—A long analysis is given to obtain a value of the diminution of heat radiation through the Martian atmosphere, and the results are compared with the glasshouse or accumulative theory. C. P. B.

1812. *Temperature of Planets.* **F. Vercelli.** (Accad. Sci. Torino, Atti, 49. 5a. pp. 298–325, 1913–1914.)—Shows on general grounds that the age, temperature, and thermal gradient of planets, calculated by Fourier's method, must be considered as minimum values. Applying the method on a wider range to spheres, and using elliptic functions, the author deduces 187 million years as the minimum time since solidification began. The absolute temperature at the centre after the same period rapidly increases with the diameter of a planet, being 0° in the case of Eros, 40° in the case of Juno,

2000° for Vesta, and 4000° for all planets from the size of the moon upwards. This supposes that the physical structure of the planet is similar to that of the earth. The temperature gradient would thus be of the order of that of the earth for the larger planets, but would be very low for the planetoids.
E. E. F.

1813. *Statistics of Satellite Orbits.* **J. Delauney.** (Comptes Rendus, 158. pp. 1405–1407, May 18, 1914.)—Investigating the periods of revolution of the satellites of Saturn, the author finds the relation that their second differences are in the ratio of the progression 1 : 3 : 9 : 27 : 81 .... C. P. B.

1814. *Numbers of Stars in Different Galactic Latitudes.* **S. Chapman** and **P. J. Melotte.** (Roy. Astronom. Soc. Memoirs, 60. Part 4. pp. 145–178, 1914.) —The investigation aims at providing a reliable estimate of the number of stars classified according to their apparent brightness and position in the sky. Counts were made for selected regions on photographs taken with the Franklin-Adams camera, and formulæ are developed by means of which the star density down to any magnitude and galactic latitude may be deduced. The results are tabulated in four galactic groups. C. P. B.

1815. *Spectroscopic Binaries and Velocity of Light.* **R. S. Capon.** (Roy. Astronom. Soc., M.N. 74. pp. 507–517, April, 1914.)—Michelson having recently shown that the velocity of light is unaffected by reflection at a moving mirror [Abstract No. 1265 (1913)], it was of interest to investigate the possibility of the velocity being affected in the case of motion of the light source—for example, in the component stars of spectroscopic binaries. From a study of the distribution of periastra of such systems it is concluded that any effect of the velocity of the source on the velocity of light is certainly very small. There is some tendency to systematic grouping of the periastra which needs investigation. C. P. B.

1816. *Variable Star VV* (17·1912) *Aurigæ.* **H. G. S. Barrett.** (Roy. Astronom. Soc., M.N. 74. pp. 538–540, April, 1914.)—The variability of this star was detected during the examination of photographic plates taken with the 24-in. refractor at Radcliffe Observatory, Oxford. A table is given showing the observations from 1912 Jan. 26, to 1914 April 6, and a drawing of the determined light-curve, indicating a period of 416 days. C. P. B.

1817. *Total Light of the Stars.* **S. Chapman.** (Roy. Astronom. Soc., M.N. 74. pp. 446–451, March, 1914.)—Utilising the data collected in a series of counts of stars on photographic records, classified according to their Harvard photographic magnitudes down to 17·0, in various galactic latitudes, the analysis leads to the conclusion that the total light of all the stars is equal to that of 631 stars of the first magnitude. Various corrections are applied which alter this to the equivalent of 690 stars of the first magnitude for the total light of all stars. This being in terms of the photographic standard, it is also given as equivalent to 900 or 1000 on the visual scale, as the photographic magnitude of the average star is numerically greater than the visual magnitude. C. P. B.

1818. *Constitution of Nebulæ.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 74. pp. 486–506, April, 1914.)—A definite theory is presented to account for the chemical constitution of nebulæ, based on the discussion of the nebular spectrum on the electronic hypothesis. The average spectrum appears to show the presence of (*a*) The various simple ring-systems, with simple nuclei, showing only spectral lines which are apparently distributed at random. (*b*) The first products of some form from these systems which leads ultimately to the Wolf-Rayet stars, in which series analogous to the terrestrial spectral series may be found. (*c*) Hydrogen and helium, the simplest terrestrial elements, the former of these being included in (*b*). It is thus concluded that the chemical substance of the nebulæ consists of the beginning of matter; the electrons not being held very firmly in the atoms, permitting a continual interchange of electrons, with a necessary bombardment of atoms by free electrons, to which the luminosity is probably due. The physical state of a nebula might thus be compared to that in a very exhausted vacuum tube of enormous extent.

By the consideration chiefly of neutral atoms many nebular lines have been accounted for by the analysis. C. P. B.

1819. *Radial Velocity of Orion Nebula.* **H. Bourget, H. Buisson,** and **C. Fabry.** (Comptes Rendus, 158 pp. 1269–1271, May 4, 1914.)—A series of photographs of the Orion nebula have been made with the interferential spectrometer, using a difference of path of 2 mm. in the étalon, from which the radial velocities of different parts of the structure have been determined. The mean velocity of the nebula with respect to the sun is given as +15·8 km. per sec., indicating a motion away from the solar system. The various subsidiary motions observed suggest a type of rotation about the axis passing SE. and NW. By comparison with terrestrial spectra the actual wave-lengths of the components of the strong ultra-violet nebula line have been determined to be λ3726·100 and λ3728·838. C. P. B.

1820. *Atomic Weight of Elements in Nebulæ.* **J. W. Nicholson.** (Comptes Rendus, 158. pp. 1322–1323, May 11, 1914.)—From the analysis representing the element nebulium as consisting of a central positive nucleus with four electrons in the encircling ring, the atomic weight of this system would appear to be 1·31. What the author calls protohydrogen is assigned an atomic weight of 0·0818, and archonium, represented by the ultra-violet lines, a weight of 2·945. C. P. B.

## LIGHT.

**1821.** *Polarising Prisms for the Ultra-violet.* **S. S. Richardson.** (Phil. Mag. 28. pp. 256–268, Aug., 1914.)—Requiring a beam of polarised ultra-violet rays, the author found that the prisms employed transmitted no light of higher refrangibility than about 3000 Å.U. The polariser and analyser were both large prisms of the Foucault type, and, since Iceland spar is quite transparent as far as λ2140, the want of transmission was due obviously to the reflection of the extraordinary ray, as well as the ordinary, at the air-film. In view of this the author has determined the limiting values of the angles of inclination of the air-film for transmitting polarised beams of short wavelength for the cases of: (1) A square-ended Foucault, the end faces being perpendicular to the line of vision, and to the planes containing this line and the optic axis; (2) an ordinary Foucault, the end faces being the natural ends of the crystal; and (3) a Glan-Foucault prism. Tables of results are given. The angular diam. of the polarised beam is found to be much increased by the use of a suitable cement for the two halves of the prism. Canada-balsam is inadmissible in ultra-violet work, as even in thin films it arrests all rays beyond λ3400, but liquids such as castor-oil and glycerine can be used. The author hopes to deal with cemented prisms in a later paper.

H. H. Ho.

**1822.** *Measurement of Cloudiness.* **W. Mecklenburg and S. Valentiner.** (Zeitschr. Instrumentenk. 34. pp. 209–220, July, 1914.)—Describes an apparatus, devised by the authors and termed by them a Tyndallmeter, which, by the method of Tyndall's experiment to imitate the blue colour of the sky, gives a measure of the cloudiness of any substance (solid, liquid, or solid particles suspended in liquid). One portion of a horizontal beam of light from a Nernst filament traverses the substance under investigation in the interior of which part of it is scattered upwards and illuminates one face of a Lummer-Brodhun photometer head. The remainder of the beam is reflected from a plaster surface, and after traversing three Nicol prisms in succession illuminates the other surface of the Lummer-Brodhun head so that the intensities of the two portions of the beam may be compared. The second of the three Nicol prisms is capable of an accurately measurable rotation while the other two remain fixed with parallel axes. By this means any desired dimming of the light traversing the prisms may be obtained, and if $\phi$ is the angle of rotation of the middle prism from the crossed position, the intensity of the beam is proportional to $\sin^4 \phi$. The effect of simple absorption of the beam by the substance is eliminated by taking several observations in positions at which the beam traverses different thicknesses of the substance. The effect at zero thickness is then obtained graphically by extrapolation. This is done for the effect of absorption on (*a*) the original beam before scattering takes place, and (*b*) the scattered light. As examples of the uses to which the instrument may be put, and of the method of experiment, detailed accounts of experiments on uranium glass, white of egg, silver chloride suspended in water, and Zsigmondy's red colloidal gold solution are given. Of particular interest are the similar experiments on town waste-water both before, and after various stages of, filtration. As a useful addition to the instrument there is included an arrangement of prisms by means of which the beam of light traversing the substance may be shifted parallel to its original direction, in order to investigate the brightness of the substance at any given distance from the exciting beam. The description of the apparatus is illustrated by two clear diagrams and a sketch of the complete instrument. J. W. T. W.

1823. *Transmission and Reflection Photometer for Small Areas.* **P. G. Nutting** and **L. A. Jones.** (Washington Acad. Sci., Journ. 4. pp. 313–315, June 19, 1914. Communication No. 15 from Research Lab. of Eastman Kodak Co.)—In many optical investigations it is desirable to measure the brightness of areas 1 mm. square or less. The instrument here described was devised for measuring the brightness of optical images, the local densities in photographic negatives and the reflecting powers of photographic prints. It is stated to have proved exceedingly convenient and precise, and to be easily, quickly, and permanently adjustable. For months it has been in constant use by a number of observers for sensitometry of photographic plates and papers. With a magnifying ocular it has even been used as a microphotometer of low power. The chief advantages claimed are: (1) Elimination of errors due to fluctuation in the comparison source by making the same light serve for both sources. (2) Elimination of corrections for shift of zero by providing easy means of balancing the two beams with an open system. (3) Direct view of the object sighted upon at all times during measurement. This is obtained by focusing an image of that object at the dividing line of the photometer cube. (4) An open linear scale, reading directly from zero to 100 %, provided by a rotating comparison beam and stationary sector. The photometer head used is, in fact, that of the Bechstein illuminometer. The source of light E is a condensed filament 100-watt tungsten lamp run on the lighting circuit. One beam of light from the source travels in a direct path through a comparison screen of thin solid opal glass, a stationary sector S, a rotating excentric lens L, and a photometer cube P, to the ocular O. Another beam from the source E travels to the photometer cube P in a path forming three sides of a rectangle $ER_1R_2P$, with reflecting prisms at the corners $R_1R_2$. The first reflecting prism $R_1$ is inside a metal box mounted on a stand. The front face (at which the beam emerges) of this box is a plate of flashed opal glass D, which serves as a secondary source by diffusing the light. The plate whose transmission is to be determined is placed directly in front of this diffusing screen, thus eliminating errors due to diffusion in the transmission measured. An image of this observed plate is thrown on the photometer cube P by means of the second reflecting prism $R_2$, and a lens placed between $R_2$ and P. This lens (which is adjustable in position), and the prism $R_2$, are mounted on an arm carried by the instrument. In use, before inserting the plate to be measured, the sector S is first set to read 100, and the source E moved to and fro until a balance is secured. The instrument will then read percentage transmission from 0 to 100 %, with very slight zero correction. For determining reflecting powers, $R_1$ and D are not used, and $R_2$ is rotated to face downward instead of horizontally. The surface to be measured is placed directly under $R_2$ on the table, and illuminated directly by the source E at about 45°. If only relative values are desired, clear paper is placed in the field, the sector set to read 100 %, and the source E adjusted to give a match at the cube. If actual reflecting powers are desired, a matt surface, say a block of magnesium carbonate, whose reflecting power has been determined on an absolute reflectometer, is placed in position, the sector S set to read its absolute reflecting power, and the source E adjusted as before. The instrument will then give directly the diffuse reflecting power of any other surface placed in the field. A. E.

1824. *Registering Microphotometer for Laboratory Spectra.* **A. S. King** and **P. P. Koch.** (Astrophys. Journ. 39. pp. 213–229, April, 1914. Contribution from the Mount Wilson Solar Observatory, No. 77.)—A preliminary study has been made of the application of the microphotometer in registering the distribution of photographic density over the width of spectrum lines. It is found that a quantitative measure is obtained of the relative strengths of lines having very different appearance, especially the sharp and diffuse lines often occurring in the same spectrum, when the max. density of the line cannot be taken as a measure of its intensity. It is also applicable to determine the characteristics of lines given by the electric furnace at different temperatures. The intensity curves for electric-furnace lines when displaced by pressure show that a line, if originally sharp, may maintain a structure very nearly symmetrical through a wide range of pressure. This indicates that the pressure effect does not appear to be the result of unsymmetrical widening, and the symmetry of reversals is further evidence of a lack of dependence on temperature or vapour density. C. P. B.

1825. *Crystallography.* **F. Canac.** (Comptes Rendus, 159. pp. 405–408, Aug. 10, 1914.)—Describes a new method of making crystallographic measurements by means of Röntgen rays. Utilising the experiments of Laue and Terada [see Abstract No. 1160 (1913)] it is found possible, from a study of the manner in which the spots are displaced when a crystal is made to turn about certain axes (normal to the fundamental section), to construct the lattice and to calculate its parameters. Measurements were made on a sugar crystal, and results were obtained in close agreement with those obtained by Wolff by ordinary optical measurements. [*Errata.* Ibid. p. 516, Sept. 21, 1914.] A. W.

1826. *Refractive Index and Density.* **I[rene] M. Mathews.** (Frank. Inst., Journ. 177. pp. 673–686, June, 1914.)—This paper gives a descriptive account of the deduction and testing of the three chief equations connecting these properties, viz. (1) $(\mu^2-1)/d =$ const., (2) $(\mu^2-1)/(\mu^2+2)d =$ const., and (3) $(\mu-1)/d$ = const. The sum-total of the evidence points to the general validity of the latter two, and for low densities both relationships appear to be equally good. Some doubt, however, remains as to whether (2) or (3) holds when the temperature is varied, and this point has now been tested for oxygen with a Fabry and Perot interferometer. An arrangement is described by which the difference between the laws (2) and (3) at pressures of about 3 atmos. can be detected. C. S. G.

1827. *Enclosed Cadmium Arc.* **T. M. Lowry** and **H. H. Abram.** (Faraday Soc., Trans. 10. pp. 103–106, Aug., 1914. Chem. News, 109. pp. 171–173, April 9, 1914.)—Describes a cadmium arc of the enclosed type for use in polarimetric work. The arc is run between water-cooled electrodes of solid cadmium, because if the metal is allowed to melt it is liable to crack the tube whenever the lamp is started or stopped, and with solid electrodes there is less vaporisation of the metal. The electrodes are contained in two side-tubes sealed into a horizontal tube near its middle point, and this horizontal tube is provided with quartz windows at the ends. In the most recent form of the lamp the ends of the horizontal tube are provided with water-jackets to prevent as much as possible the condensation of metal on the quartz windows, but the water-jacketing must not extend to the central part of the tube, which must remain hot in order to prevent the formation of a conducting bridge of condensed metal. An arch of silica between the two side-tubes containing the electrodes serves to bring the arc to the centre of the tube. The lamp must be used in conjunction with a Gaede pump, as the metal gives off considerable quantities of gas under the influence of the electric discharge. Occasionally, when the vacuum is good, the arc will start itself when the current is switched on, but usually it is necessary to start the arc by a spark. An example of the use of the lamp is given in the case of $\alpha$ and $\beta$-methylglucoside. It was desired to find not merely the magnitude of the constants in the dispersion equation, but also whether these two compounds, containing no less than five asymmetric carbon atoms, nevertheless obeyed rigidly the simple dispersion law. The results show that the readings taken with the green and red Cd lines are quite as reliable as those taken with the violet and green Hg lines for working out the rotation constant $k$ and the dispersion constant $\lambda_0^2$ for either substance. It was found that the simple dispersion formula very accurately represents the experimental data for the $\alpha$-methylglucoside. The readings for the $\beta$-methylglucoside are not so concordant, in part because they are 5 times smaller; but they agree sufficiently well to show there is no large deviation from the simple dispersion law.

The development of the enclosed Cd arc promises to inaugurate a new era in the measurement of simple rotatory dispersion. With the help of the new apparatus it will be possible to determine the two fundamental constants of any optically active compound by two methods of equal exactness. Further, the agreement of the two pairs of figures will serve as a check, not merely on the accuracy of the readings, but also on the strict validity of the dispersion formula in the case of each individual substance. A. W.

1828. *Simple and Complex Rotatory Dispersion.* **T. M. Lowry** and **T. W. Dickson.** (Faraday Soc., Trans. 10. pp. 96–102, Aug., 1914.)—Recent investigations on the rotatory dispersion of light in quartz show that this cannot be represented, even within the limits of the visible spectrum, by Drude's simplified equation, $\alpha = k_1/(\lambda^2 - \lambda_1^2) + k'/\lambda^2$ ("Theory of Optics," 1907, p. 413). Very satisfactory agreement between the observed and calculated values is obtained, over the whole range from a wave-length of 16740 to one of 2327 Å. units, by means of Drude's general equation with three terms, namely, one infra-red term and two ultra-violet terms: $\alpha = k_0/(\lambda^2 - \lambda_0^2) + k_1/(\lambda^2 - \lambda_1^2) + k_2/(\lambda^2 - \lambda_2^2)$. In this equation $\lambda_2^2$ is 78·22, as given by Drude and $\lambda_1^2$, a constant differing somewhat from Drude's figure, 0·010627, while $\lambda_0^2$ represents another wave-length in a remote part of the inaccessible ultra-violet region. Equally good agreement may, however, be obtained by replacing the whole of the infra-red term by a constant, putting $\lambda_0^2 = 0$ and regarding $\lambda_1^2$ as an unknown quantity, thus: $\alpha = k_0/\lambda^2 + k_1/(\lambda_2 - \lambda_1^2) + k_2$.

For simple organic liquids the curves of optical and magnetic rotatory dispersion are expressed, within the limits of the visible spectrum, by the simple equation, $\alpha = k/(\lambda^2 - \lambda_0^2)$. This fact does not, however, prove that these substances are characterised by only one natural period of free vibration, since the optical rotatory power of quartz—which is known to possess four such natural periods—can be represented within the same limits of accuracy by this simple formula. The anomalous rotatory dispersion of ethyl tartrate may be represented by a Drude formula containing two terms of opposite sign, and photographic data obtained show that, as the limit of the visible spectrum is approached, the rotation changes in sign and the ester becomes strongly lævo-rotatory. The form taken by the equation in this case may be due to: (1) two vibrations of unequal period and opposite activity; (2) the superposition of two "partial rotations," or (3) the actual presence of two distinct substances. Dynamic isomerism as a cause of anomalous rotatory dispersion is discussed.

Instead of making a distinction between "normal" and "anomalous" dispersion, it would be more satisfactory to distinguish between simple rotatory dispersion, expressible by the equation, $\alpha = k/(\lambda^2 - \lambda_0^2)$, and complex rotatory dispersion, which requires an equation containing two or more terms, thus: $\alpha = k_1/(\lambda^2 + \lambda_1^2) + k_2/(\lambda^2 + \lambda_2^2) + \ldots$. —T. H. P.

1829. *Pressure Shift of Zinc Spectrum Lines at Low Pressures.* **V. F. Swaim.** (Astrophys. Journ. 40. pp. 137–147, July, 1914.)—This paper describes a continuation of the work of Gale and Adams [see Abstract No. 81 (1914)] on the effect of pressure upon arc lines. The pressures employed range from 5 cm. to 2·2 atmos., and photograms were made in the second order of a Rowland grating where the dispersion was about 1 mm. per Ångström. The region investigated extends from λ4811 to λ3076, and the results are tabulated in mean redward shifts (Δ) per atmosphere. Lines in the first and second subordinate series as well as non-series lines are examined, and on the basis of the classification of the former by Gale and Adams the relationships between λ and Δλ are worked out. The displacement at a particular pressure of lines of the first subordinate series varies as $1/\lambda^2$ and of the second subordinate series as $1/\lambda$, whilst for non-series lines the displacement is directly as $\lambda^2$. The first subordinate series line at λ2802·11 behaves, exceptionally, as a non-series line. C. S. G.

1830. *Absorption Spectrum of Zinc-vapour.* **J. C. McLennan.** (Phil. Mag. 28. pp. 360–363, Sept., 1914.)—Wood and Guthrie [see Abstract No. 1215 (1909)] found no trace of any absorption with zinc-vapour in the range of the spectrum investigated by them, which began at about λ5200 and apparently did not extend beyond λ2150. In view of the prediction made by Paschen and subsequently confirmed by Wolff [Abstract No. 239 (1914)] that the emission spectrum of zinc should include a series of single lines with the first member of the series at λ2139·33, it seemed desirable to look for absorption by zinc-vapour in the region below λ2150. Some pure zinc was placed in a clear fused quartz tube 2 cm. in diam., which was then highly exhausted and sealed up. This tube was placed before the slit of a quartz spectrograph and heated with a Bunsen burner. When the spark between zinc terminals in air was used as the source of light, it was found that the vapour evolved when the zinc was melted and raised to a red heat was sufficient to cut out completely the line λ2139·33. With this moderate heating the absorption band was sharp and quite narrow. With stronger heating, however, the band widened symmetrically, and with very strong heating with a Méker burner it could easily be made to cover a range of from one to two hundred Å. units. No trace of any other absorption was found either above λ2139·33 or in the region of the spectrum below this line down as far as λ1840. From observations on such factors as intensity, line structure, Zeeman-effect, and Doppler-effect, Stark has been led to take the view that the line λ2536·72 belongs to the Hg single-line series, and that it is really the first member of that series; *i.e.* according to him the Hg line λ2536·72 and not the Hg line λ1849·6 is homologous with the Cd line λ2288·79 and the Zn line λ2139·88. Various considerations regarding absorption here advanced lend some support to this theory. Since the evidence adduced so far indicates that we should expect to find absorption by the vapours of Hg, Cd and Zn at λ1402·71, λ1669·8 and λ1589·64 respectively, it suggests that the lines of Paschen's single-line series in the emission spectra of these three metals correspond to the system of electric vibrations which is most easily set up in the atoms. This would fit in with the view expressed by Stark that the lines of these three series are the ones which correspond to atoms of Hg, Cd, and Zn in the neutral state. A. W.

**1831.** *Wave-lengths of Hydrogen Lines and Determination of Series Constant.* **W. E. Curtis.** (Roy. Soc., Proc. Ser. A. 90. pp. 605–620, Sept. 7, 1914.)—The author has determined in International units, with an accuracy of about 0·0001 Å. the wave-lengths of the first six lines of the Balmer series of hydrogen. The Balmer series formula is found to be inexact, and instead the results may be represented by a modified Rydberg formula containing only two constants thus: $n = \mathrm{N}/4 - \mathrm{N}/(m+\mu)^2$, where $\mathrm{N} = 109{,}679{\cdot}22$ and $\mu = +0{\cdot}0569$. For the measurements a 10-ft. concave grating was used, with which an accuracy of 0·001 Å. in the third order is obtainable when exposures are short (under half an hour). With longer exposures it was found to be very difficult to obtain accurate determinations on account of the difficulty of controlling sufficiently the temperature variations of the instrument. As standards the tertiary iron arc lines determined by Burns were employed after their accuracy in the region investigated had been tested and found satisfactory. Full details are given in the paper of all the refinements tending towards accuracy, and the resulting measurements are tabulated with the former measurements of Rowland, Ames, Dyson, Evershed, and Mitchell. C. S. G.

**1832.** *Atomic Structure and Helium Spectrum.* **J. W. Nicholson.** (Phil. Mag. 28. pp. 90–108, July, 1914.)—Bohr's theory of spectra, in spite of its very general assumption, fails for lithium and the heavier elements [Abstract No. 1246 (1914)]. It must therefore stand or fall by the extent to which it accounts for the spectra of hydrogen and helium. Now for all ordinary elements whose spectra can be put into series of Rydberg's approximate type, there are three main series, viz., where B is Rydberg's constant, and $p$, $s$, $d$ are definite constants for the elements; Diffuse, $\nu = \mathrm{B}\,[(1+\mathrm{S})^{-2} - (m+d)^{-2}]$; Sharp, $\nu = \mathrm{B}\,[(1+\mathrm{S})^{-2} - (m+p)^{-2}]$; Principal, $\nu = \mathrm{B}\,[(1+p)^{-2} - (m+\mathrm{S})^{-2}]$. On Bohr's theory, these obviously require the existence of three different types of stationary types, to which the constants $m$, $s$, $p$ are individually peculiar, and that the spectral series are formed during the passage of the atom, not between different states or configurations of the same type, but between different types of states. But if the He-atom contains only two electrons, with comparatively inert nucleus, the degrees of freedom are insufficient for three types—and the He spectrum contains six such series, with six apparently independent constants. Moreover, the He-atom, according both to Bohr's theory and J. J. Thomson's experiments, will not take up an extra electron, so that the neutral atom and the atom which retains only one electron are alone left to explain the entire spectrum. Now the author has shown [Abstract No. 1247 (1914)] that the observed He spectrum is not obtainable on the present form of Bohr's theory, and that none of the possible steady states of the two electrons leads to a formula approaching Rydberg's. It is found that for more than one electron Bohr's theory must admit the additional hypotheses that: Nuclei attract bound electrons according to the inverse square law: Bound electrons do not mutually repel according to this law: The angular momentum of an electron may cease to be $\tau h/2\pi$, when $\tau$ is an integer, if there are other electrons present. Considering Bohr's Li-atom model of three electrons and a nucleus, the law of force of the second hypothesis is shown to be either—No force at all, or any law whatever, provided that the three electrons are in one ring. But the latter alternative cannot take account of the valency of lithium. Direct distance laws are formally possible for electrons on confines of nucleus—but these are just $\beta$-particles, and any combination of them with those of first hypothesis leads to Li-spectrum indistinguishable from that of H. Therefore the zero force hypothesis remains the only one; and this can be generalised for any element, giving an atom in which any electron is acted on by the nucleus only, and behaving therefore as simply as the electron in a H-atom. Such an hypothesis is a step towards J. J. Thomson's conception of tubes of force in the atom.

Returning to the He spectrum, assumed to contain nucleus $2e$ and two electrons only, mathematical analysis shows that no possible law of electronic repulsion can lead to any He series corresponding with observation, and that even the abandonment of the hypothesis that $\tau$ is an integer, and its replacement in Bohr's expression for the angular momentum by $f(\tau)$, a function of an integer $\tau$ and also of the nuclear charge and the number of electrons in the atom, leads to the conclusion that—Bohr's theory cannot explain the He spectrum, or any other series spectrum, by any modification which will retain the simpler theory of H and the Pickering series, with or without force between bound electrons. And the argument can be extended to nuclei $3e$ and $4e$. The final conclusion, therefore, is that Bohr's theory cannot give the spectrum for any atom, and is incapable of further development in the interpretation of spectra.

G. W. DE T.

1833. *Effect of Self-induction on the Nitrogen Bands.* **E. P. Lewis.** (Astrophys. Journ. 40. pp. 148–153, July, 1914.)—The author has extended his former observations made in 1903 and 1906. Self-induction causes the appearance of negative bands everywhere, but the most striking changes are produced in the positive bands. In these latter, compared with the spectrum of the simple discharge or that of a small Tesla coil, self-induction and capacity produce a relative enhancement of the more refrangible lines belonging to the principal head so that they can be easily followed to the head of the next group. Sub-heads are almost completely suppressed and the lines are sharpened up considerably. The group extending from a head at λ3371 is chiefly dealt with and the new lines revealed fit well into a Deslandres formula. There is reason to believe that this band is composite, all but the principal series being suppressed by self-induction. C. S. G.

1834. *Ultra-violet Spectrum of Neo-ytterbium.* **J. Blumenfeld** and **G. Urbain.** (Comptes Rendus, 159. pp. 401–405, Aug. 10, 1914.)—In a previous paper the authors have described a method of obtaining neo-ytterbium. Tests of the paramagnetism of a series of consecutive fractions showed practical constancy, evidence that the separation was complete. Measurements have now been made of the arc spectra of the extreme fractions of this series. The spectra are identical with the exception of a few faint lines which have been identified with lines of thulium and lutecium. Wave-lengths of the lines (which range from λ2300 to λ3500), with remarks as to their sharpness and intensity, are given. A. W.

1835. *Spectrum of Elementary Silicon.* **W. Crookes.** (Roy. Soc., Proc. Ser. A. 90. pp. 512–520, Aug. 1, 1914.)—Former workers have never made complete investigations of the spectrum lines of this element from the ultra-violet right to the extreme red. Moreover, their results show many differences, doubtless due to the varying degrees of purity of the specimens employed. Both these objections have been overcome, and the lines have now been mapped continuously from λ2124 Å. to λ6871 Å. Silicon up to 99·98 % purity was obtained from the Niagara Falls Carborundum Co., and utilised as electrodes with high-frequency current. Oxidation and pitting of the poles is overcome by frequent grinding on an emery wheel. In practically all regions records are obtained photographically and referred to the iron standard, but in the case of a few faint lines in the orange-red, eye observations are employed, and for this purpose a specially devised recording attachment is fitted to the eyepiece of the 5-prism spectrograph. C. S. G.

1836. *Red Lithium Line.* **T. Takamine** and **K. Yamada.** (Mathematico-Physical Soc., Tōkyō, Proc. 7. pp. 339–342, July, 1914.)—By photographing the absorption lines of λ6708 of lithium Zeeman has shown that very probably this line is a doublet with $d\lambda = 0{\cdot}144$ Å.U. The authors now show that the doublet can be obtained in the emission spectrum if a specially regulated brush discharge is utilised as light source in conjunction with a Hilger grating. A separation $d\lambda = 0{\cdot}165$ Å.U. is found in the emission doublet. Several tests are applied to substantiate the true duplicity as distinct from mere reversal. This measurement of $d\lambda$ reaffirms the exceptional behaviour of Li; for the value of the ratio of the difference of the oscillation frequencies between the doublet and the square of the atomic weight, which holds for all the other alkali metals, does not hold for Li. The character of the spectrum of the brush discharge is very different from that of the ordinary spark spectrum of the metal. C. S. G.

1837. *Spectroscopy of Secondary Röntgen Rays and their Absorption Spectra.* **M. de Broglie.** (Comptes Rendus, 158. pp. 1493–1495, May 25, 1914.)—When X-rays from a Röntgen bulb are allowed to fall on a metal, the latter will, if the rays are of the right hardness, give off its characteristic radiation. By exposing a body whose spectrum was required to the direct rays from a bulb and placing the spectroscope slit so as only to receive the secondary rays, the author has managed to obtain definite spectra. With brass for instance as radiator, and a crystal of rock salt turning at an angular velocity of about 7° to 8° per hour as reflector, a spectrum was obtained showing clearly the characteristic lines of the constituent elements of the brass. This arrangement has an advantage over that in which the metal acts as antikathode inside the bulb, in that it is quicker and less laborious.

Some experiments were carried out on the absorption of the rays. The absorbing screens are either placed just in front of the spectroscope slit or in front of the photographic plate to obtain the absorption spectra, but in order to get a clear well-defined spectrum the exposures have to be sufficiently prolonged. By interposing a sheet of Cu-foil, 0·01 mm. thick, between the radiator and the plate, an absorption band is observed in the spectrum which stretches from about 14° 15′ to 10°. This affords a confirmation of the fact stated by Barkla and Sadler, that elements possess in general a band of absorption for wave-lengths shorter than those of their characteristic rays. The author points out that the intense bands described in former communications [see Abstracts Nos. 675, 676, 1080 (1914)] as being present in all the spectra hitherto obtained, may be due to the fluorescence of the AgBr constituting the emulsion of the photographic film; the band in the region of the shorter wave-lengths would correspond to Ag and the other to Br. This interpretation appears to be a plausible one. E. A. O.

1838. *Direct Spectral Analysis of Secondary Röntgen Rays.* **M. de Broglie.** (Comptes Rendus, 158. pp. 1785–1788, June 15, 1914.)—In a previous communication [see preceding Abstract] the author described a method of obtaining the spectra of bodies without using them as antikathodes inside a bulb. In the present paper some preliminary results obtained by this method are given. The spectral lines can be obtained with relatively short exposures by taking as source a compound of the element to be investigated, functioning as a secondary radiator, and exposing it to the rays from a bulb with a Pt or W antikathode which has a current of from 4 to 5 milliamps. passing through it. The secondary spectra photographed by this method compare favourably with those obtained by Moseley who used the primary rays direct from a bulb. The following are some of the results :—

| Element. | Chemical State. | Angle of Reflection of the Rays from Rock Salt. | |
|---|---|---|---|
| Arsenic | Sulphide | 12·6° (strong) | 11·6° (feeble) |
| Selenium | Metal | 11·6 | 11·6 |
| Bromine | Sodium Bromide | 10·7 (strong) | 9·5 (feeble) |
| Rhubidium | Chloride | 9·6 (strong) | 8·6 (feeble) |
| Strontium | Chloride | 8·9 | 8·1 |
| Cadmium | Metal | 5·4 | 8·1 |
| Iodine | Zinc Iodide | 4·5 | 8·1 |
| Tellurium | Telluric Acid | 4·7 | 8·1 |
| Mercury | Zinc Amalgam | 12·9 (strong) | 10·7 |
| Lead | Metal | 12·05 | 10·0 |
| Bismuth | Metal | 11·45 | 9·4 |
| Thorium | Oxide | 9·7 | 8·0 |
| Uranium | Black Oxide | 9·5 | 7·7 |

E. A. O.

1839. *Anomalous Zeeman-effect in Satellites of Violet Mercury Line* (λ4359). **H. Nagaoka** and **T. Takamine.** (Mathematico-Physical Soc., Tōkyō, Proc. 7. pp. 331–337, June, 1914.)—In previous papers [Abstracts Nos. 1958 (1913) and 867 (1914)] on the Zeeman-effect of the satellites of the green and violet mercury lines (λ5461 and λ4047) it was shown that the changes in wave-length of the satellites produced by the magnetic field are generally different from those observed with the principal lines, both as regards the displacement and the distribution of intensity among the different components. The effect up to strong fields is in most cases anomalous, although in fields of a few thousand gauss, some regularity usually observed in simple lines may still be traced.

The present paper describes a continuation of the experiments to the satellites of the violet line λ4359. A satellite of this line in weak fields has been investigated previously by Gehrcke and v. Baeyer and by Luneland [Abstract No. 878 (1911)]. The study of the satellites of this line is specially interesting, as it is accompanied by more than ten satellites, whose modes of displacement in magnetic fields are so various that different cases of anomalies already observed in satellites of the two lines mentioned above are also found included among the diverse types found in the companions of this single violet line. The method of observation was exactly the same as in the previous work. It has generally been assumed that the principal line is simple and has finite breadth ; but by using a very high resolving power it has been found that the line really consists of five lines, three of which are nearly equally intense and form a group. The details of the experiments by which the cluster of lines about the principal line was found will be given later ; the fine structure of the lines λ5461 and λ4047 will also be dealt with. As noticed with the other two lines, the *p*-components are simpler than the *s*-components. The general features are exhibited in two diagrams, and the results are discussed in detail. The results here given, together with the earlier results, afford experimental data for testing the theory of coupling of electrons in explaining the different behaviours of the satellites in a magnetic field. A. W.

1840. *Intensity of Reflection of X-rays by Crystals.* **W. H. Bragg.** (Phil. Mag. 27. pp. 881–899, May, 1914.)—The author first summarises previous work on the question of the relative intensities of reflection of homogeneous X-rays by a crystal in the different orders and the important conclusions regarding the structure of crystal which may be drawn from the results [Abstracts Nos. 876, 1265 (1914), etc.]. The conditions to be satisfied in obtaining more exact numbers are then discussed, especially with regard to correcting for the small irregularities of the crystal. The method finally arrived at consists practically in measuring the integral of the narrow peak, corresponding to a particular wave-length, in the curve connecting the ionisation effect of the reflected rays and the angle of reflection. Values are given in the case of rock salt and it is shown that the intensities of reflection in the different orders from the various planes in the crystal are comparable with each other. In further experiments the effect of temperature of the rock salt on the angle and intensity of reflection was investigated, and it was found that the glancing angle diminishes with increasing temperature. The results show excellent agreement with the theory of Debye [Abstract No. 1078 (1914)]. Experiments are also described showing that when a plate of diamond is set, with reference to the X-ray beam, at the angle of best reflection, an abnormal absorption is obtained, the variation with angle being similar to an absorption band. The various experiments give opportunity for an accurate estimate of the wave-length of the larger constituent of the rhodium doublet, the value found being $\lambda = 0{\cdot}614 \times 10^{-8}$ cm. E. M.

1841. *Asymmetric Haloes with X-radiation.* **W. F. D. Chambers** and **I. G. Rankin.** (Nature, 93. p. 507, July 16, 1914.)—It is found that a radiograph of a lead disc 2·5 mm. thick, when the disc is raised above the photographic plate, does not appear of an even intensity, but gives well within its shadow a distinct white ring. Experiment shows that the brightness, width, and diameter of this ring vary with the distances of the disc from the plate and antikathode ; it also changes from a complete circle to almost a semicircle, the position and dimensions of the absent arc depending upon the orientation of the bulb. The ring is found to be complete when the X-rays are in the plane of the kathode rays and the normal to the antikathode, and from 10° to 15° within the angle of true reflection. Diverging from this direction the circle becomes increasingly incomplete. Apertures, cubes, cylinders, solid and hollow spheres, etc., of various materials give analogous results, the form of the white area depending upon the shape of the object. The authors point out that the results seem to indicate that the X-radiation has been differentiated into two main types, one of which may consist of disparate doublets (magnetic) ; the polarity being distributed radially round a position which coincides with that of max. intensity. This phenomena bears a close analogy to that of unilateral conductivity in crystals.

(Ibid. 93. p. 611, Aug. 18, 1914.) The authors confirm the results already mentioned above. With a V-shaped aperture, the apex resting on the plate, the bands on one side are sharply defined and twice bent ; on the other side, there are several bands but they are diffuse and fainter. The diametric asymmetry excludes polarisation, and since it increases directly with the distance from the axis through the "optimum" (*i.e.* 15° from the direction at which light would be reflected) the rays must have some determination from the plane of the antikathode. In other words, they must be polarised in planes at successive angles to the direction of propagation. The continuance of the bands within the shadow beyond the range of light diffraction, and their varying asymmetry show that X-radiation is something more than light of very short wave-length, or otherwise light itself must possess unequal polarity in its structure. E. A. O.

1842. *Radiation accompanying the Oxidation of Phosphorus.* **A. Blanc.** (Comptes Rendus, 158. pp. 1492–1493, May 25, 1914.)—The author briefly describes the experimental arrangement adopted for investigating the effect accompanying the oxidation of phosphorus. It is found when phosphorus oxidises, that a very soft radiation is emitted ; this radiation is not corpuscular, but is of the nature of $\gamma$-rays. The radiation is readily absorbed in air and is entirely absorbed in a sheet of aluminium 1/50 mm. thick. The oxidation of phosphorus furnishes the first example known of a chemical reaction producing phenomena which are similar, at least in a certain measure, to radioactive phenomena. E. A. O.

1843. *Transmission of Hard X-rays.* **J. Laub.** (Phys. Zeitschr. 15. pp. 140–141, Feb. 1, 1914.)—Thick plates of charcoal or sulphur, when traversed by X-rays, emit a very homogeneous hard secondary X-radiation. The author describes a number of experiments made with such plates. Charcoal plates 8 cm. thick, exposed for 100 minutes, show on the photographic plate a distinct succession of haloes due to interference. This effect becomes even more striking when plates 9 cm. thick are used, with very hard primary rays. E. E. F.

1844. *Ionisation in a Closed Vessel.* **E. v. Schweidler.** (Phys. Zeitschr. 15. pp. 685–688, July 15, 1914.)—The ionisation in a spherical enclosure resulting from the $\alpha$-, $\beta$-, and $\gamma$-radiation from the walls of the enclosure is calculated approximately. The experimental determination as to whether radio-active impurities in the material composing the vessel walls or the specific radio-activity of the material is the origin of the ionisation inside the vessel seems, from the quantitative results obtained, quite possible. [See also Abstracts Nos. 1671 and 1672 (1913).] A. W.

## HEAT.

**1845.** *Dilatation of Ferro-Nickels over a Large Interval of Temperature.* **P. Chevenard.** (Comptes Rendus, 159. pp. 175–178, July 13, 1914.)—The dilatation of pure iron-nickel alloys has been compared with a silica tube as a standard over the temperature interval −195° to +750° C. Between the range of composition represented by pure Fe and the compound $Fe_2Ni$, the alloys were immersed in liquid hydrogen in order to ensure their being in the cold stable state before being examined for changes in dimensions on consecutive heatings and coolings. In this series the results show that the compound $Fe_2Ni$ is the limit of the reversible alloys. Between $Fe_2Ni$ and $FeNi_2$ the alloys have abnormal, quasi-reversible properties. Alloys approaching $Fe_2Ni$, show two inflections in the temperature-coefficient of expansion curve. As they approach the compound $FeNi_2$ the first inflection disappears and the second one begins to diminish in intensity. The concentration-coefficient of expansion curves have been plotted for various temperatures and constitute a proof of the existence of the compound $Fe_2Ni$.
F. C. A. H. L.

**1846.** *Heat Capacity of Metals at Low Temperatures.* **E. H. Griffiths** and **E. Griffiths.** (Roy. Soc., Phil. Trans. 214. pp. 319–357, Oct. 1, 1914. Roy. Soc., Proc. Ser. A. 90. pp. 557–560, Aug. 1, 1914. Abstract.)—Determinations of the specific heats of Al, Cu, Zn, Ag, Cd, Pb, Fe, and Na have been made at various points between room temperature and −165° C. A new method of maintaining the enclosure at the desired temperature is used in which the cooling is obtained by a direct application of the Joule-Thomson effect in air. Making use of the results obtained by Nernst at very low temperatures [Abstract No. 447 (1913)], the authors have constructed tables of atomic heats extending from 23° to 380° C. abs. The calculated values of the atomic heats at constant volume are also included for the purpose of comparing the results with those obtained from various theoretical formulæ. In the second part of the paper these formulæ are discussed, and it is shown that none of them are capable of representing the experimental results over the entire range of temperature. Debye's formula gives the nearest approximation to the experimental results over the lowest portion of the range, but systematic divergences occur at higher temperatures. This may be due either to the assumptions made by Debye being valid at very low temperatures only, or to the fact that additional heat energy to that involved in the three degrees of freedom ascribed to the atom must be taken into account.
F. J. H.

**1847.** *Formation of Dew and Hoar-frost.* **A. Lo Surdo.** (Accad. Lincei, Atti, 23. pp. 950–953, June 21, 1914.)—Calculates the time of formation of a deposit of dew and of hoar-frost on the basis of the radiation laws, and describes an experiment with a Dewar flask and metallic mirror to imitate natural conditions. The agreement is only qualitative. E. E. F.

**1848.** *Well-known Experiment in Regelation.* **S. Suzuki.** (Sci. Reports, Tôhoku Univ., Sendai, 1. No. 4. pp. 219–227, 1912.)—The explanation given by Lorentz in his "Lehrbuch der Physik" of the passage of a weighted wire through an ice block is used as the basis of a mathematical investigation into the dependence of the rate of fall of the wire upon its dimensions and conductivity, and the weight attached. The results compare favourably with those obtained experimentally under various conditions. F. J. H.

**1849.** *New Method for determining the Specific Heats of Liquids.* **E. J. Hartung.** (Chem. News, 110. pp. 126–127, Sept. 11, 1914. Paper read before the British Assoc., Australia, 1914.)—This method, which is a modification of the method of mixtures, consists in measuring the lowering in temperature of a known amount of the particular liquid on the introduction of a definite weight of dry ice contained in a thin glass bulb. The calorimeter is a thin glass vessel of about 100 c.cm. capacity, and is supported inside a silvered Dewar tube, the mouth of which is closed air-tight by a rubber stopper. Through the stopper pass a Beckmann thermometer and a thin glass stirring rod, the lower end of which is shaped to receive the ice-bulb. A third hole, lined with glass and closed with a well-fitting glass stopper, passes through the rubber stopper and serves for the introduction of the ice-bulb, this being cylindrical and containing a definite weight of distilled water, and as much silver gauze as possible, so as to ensure rapid heat conduction and to make the bulb heavy enough to sink in dense liquids. The bulb is suspended by a fine Pt-wire. The liquid to be tested is introduced into the calorimeter by means of a standardisation pipette, and the apparatus is closed until constant temperature is attained. The ice-bulb has meanwhile been frozen in a mercury bath supported in an ordinary freezing-point apparatus. When the temperature of the mercury is constant at from −8° to −4°, the bulb is removed by its suspension and rapidly lowered into the bottom part of the stirring rod in the calorimeter. The liquid is then stirred by hand until constant temperature is again attained, this usually requiring about 8 mins. Radiation corrections are applied, and the specific heat of the liquid calculated, the heat capacity of the ice-bulb being accurately known. The measurements should be made in a room at constant temperature.

The advantages of the method are simplicity, rapidity, and accuracy. With water at 25°, results agreeing to within 0·4 % were obtained. When ether was used, it was necessary to coat the rubber stopper with tin-foil to protect it. The results with ether at 25°—at which temperature ether has a vapour pressure of 545 mm.—agreed to within 1·4 %. The values found for several mixtures of sulphuric acid and water showed an average divergence of less than 1 % from the classical results of Thomsen. The apparatus is not suitable for use with a viscous liquid, such as glycerine, owing to the inefficiency of the stirring. The method could probably be extended in scope by employing a liquid other than water in the bulb.

T. H. P.

**1850.** *The Freezing-point of Benzene as a Fixed Point in Thermometry.* **T. W. Richards** and **J. W. Shipley.** (Amer. Chem. Soc., Journ. 86. pp. 1825–1882, Sept., 1914. Chem. News, 110. pp. 187–189, Oct. 16, 1914.)—One of the authors has already determined the transition temperature of a number of hydrated crystalline salts [see Abstract No. 1178 (1911)] and has shown that these afford one of the most convenient and exact means of fixing points on the thermometric scale between 0° and 100° C. Freezing-points, similarly, can be used for the same purpose on account of the comparatively small influence of pressure on the freezing-point, but the requisite purification of the liquids is frequently a matter of the greatest difficulty. In the case of benzene, however, the conditions are fairly favourable, as benzene can be obtained sufficiently pure without too great difficulty. The authors have now determined the freezing-point of carefully purified benzene (the value remaining unchanged after repeated crystallisation of the benzene) and find it to be 5·486° ± 0·002° on the international hydrogen scale. This fixed temperature may be advantageously used in connection with the ice-point of water for calibrating Beckmann thermometers. Especial attention must be paid to the temperature of the exposed column in correcting this interval for use at other temperatures. A. F.

1851. *High-temperature Measurements based on Radiation.* **C. E. Mendenhall** and **W. E. Forsythe.** (Phys. Rev. 4. Ser. 2. pp. 62–70, July, 1914.)—An attempt to apply Stefan and Boltzmann's fourth-power law of radiation to the measurement of the highest temperatures attainable. The authors succeed in extending the high-temperature scale without extrapolation to 2820° C., and show that the optional scale based on Wien's displacement law is in close agreement with the total-radiation scale. The latter was compared with the Day and Sosman gas scale over the range 1063° C. to 1549° C., and found to agree with it within 0·5 deg. Three determinations of the melting-point of Pt gave the result 1758° C. on the Stefan-Boltzmann scale. E. E. F.

1852. *Rapid Laboratory Method of measuring the Partial Vapour Pressures of Liquid Mixtures.* **M. A. Rosanoff, C. W. Bacon,** and **R. H. White.** (Amer. Chem. Soc., Journ. 36. pp. 1803–1825, Sept., 1914.)—The authors describe a method for the determination of the partial vapour pressures of liquid mixtures, depending on the following principle. The mixture is distilled, with careful avoidance of reflux condensation, and the distillate collected in separate small fractions, the composition of which is then determined by a refractometric method. By this means one can determine the composition of the distillate when its weight is, say, 1 gm., 2 gm., 3 gm., etc., and by a small extrapolation backwards to zero weight of distillate one obtains the composition of the first indefinitely small amount of distillate, which gives therefore the composition of the vapour in equilibrium with the original liquid mixture. By this method, which is rapid and requires no special experience on the part of the manipulator, the authors have carried out measurements of the vapour pressure of the following binary mixtures: carbon disulphide—carbon tetrachloride; chloroform—toluene; acetone—toluene; ethyl iodide—ethyl acetate. A. F.

1853. *Measurement of Vapour Pressures by the Dynamic Method. Vapour Pressure of Water at 24·97°.* **I. H. Derby, F. Daniels,** and **F. C. Gutsche.** (Amer. Chem. Soc., Journ. 36. pp. 793–804, May, 1914.)—A new saturator was devised, consisting of two 3-in. bulbs filled with 4-mm. glass-pearls and kept rotating below the water-level of a thermostat; experiments showed that air drawn through at the rate of 50 litres per hour could be saturated completely with water-vapour. The vapour could then be absorbed completely by phosphoric oxide and weighed. The vapour pressure of water was found to be 23·70 mm. at 24·97°, = 23·75 mm. at 25·00°; earlier determinations by various workers have given 23·55, 23·76, 23·69, 23·79, 23·76, 23·71, 23·75, the average (omitting Regnault's early value) being 23·74 mm. at 25·00° C. A determination of the vapour pressure of alcohol gave 58·47 mm. at 25°. T. M. L.

**1854.** *Firing of Gases by Adiabatic Expansion.* I. *Photographic Analysis of the Flame.* **H. B. Dixon, L. Bradshaw,** and **C. Campbell.** (Chem. Soc., Journ. 105. pp. 2027–2035, Aug., 1914.)—In order to study the initiation of the flame produced by the adiabatic compression of gases, experiments were made in glass tubes so arranged that the flame could be analysed by being photographed on a rapidly moving film. In the case of a mixture of oxygen and carbon disulphide, which was chosen first because of its low ignition-point and of the actinic character of its flame, the flame always took an appreciable time to spread through the space occupied by the gas, and in no instance did the flame travel through the tube with a velocity approaching that of detonation; the greatest velocity observed was 100 m. per sec., whereas in the same mixture the explosion-wave travels at a rate of nearly 1800 m. per sec. The minimum volume observed when a gaseous mixture is fired by adiabatic compression is found to be no criterion of its ignition-point. Not all explosive mixtures of gases "detonate" when they are fired by adiabatic compression. In the cases examined the flame, after its appearance, takes an appreciable time to spread through the mixture, and meanwhile the piston may continue to advance if there is nothing to check it but the explosion itself. The real ignition-point is, however, not necessarily synchronous with the appearance of the flame, being the temperature at which a mass of the gas self-heats itself by combination until it bursts into flame. If the piston move during the actual spread of the flame it may naturally move during the "pre-flame" period. Experiment shows that not only is this period not negligible but that it may be much longer than the flame-spreading period. In order to determine the ignition-point by the compression it is therefore necessary to stop the motion of the piston artificially at the beginning of the pre-flame period. [Compare next Abstract.]
T. H. P.

**1855.** *Firing of Gases by Adiabatic Compression.* II. *Ignition-points of Mixtures containing Electrolytic Gas.* **H. B. Dixon** and **J. M. Crofts.** (Chem. Soc., Journ. 105. pp. 2036–2053, Aug., 1914.)—The authors have devised an apparatus which satisfies moderately well the conditions necessary for the determination of the ignition-points of gases by adiabatic compression. This apparatus and its principal sources of error are described in detail. In the case of electrolytic gas ($2H_2 + O_2$), no alteration occurs in the final ignition-point when the initial temperature of the mixture is varied, although in one case, when the initial temperature was 100°, the pressure in the cylinder at the moment of ignition was only 14·5 instead of 35 atmos., the pressure usually reached at room temperatures. Increase of the initial pressure of electrolytic gas to 2 atmos. is without influence on the calculated ignition-point, but its diminution to 0·5 atmo. is accompanied by appreciable rise of this temperature. The ignition point of electrolytic gas is found to be 526°. The following temperatures are for mixtures of $2H_2 + O_2$ with the indicated proportions of oxygen, hydrogen, or nitrogen:—

| | | |
|---|---|---|
| $O_2$, 511° | $H_2$, 544° | $N_2$, 537° |
| $7O_2$, 478 | $2H_2$, 561 | $2N_2$, 549 |
| $15O_2$, 472 | $4H_2$, 602 | $4N_2$, 571 |
| $31O_2$, — | $8H_2$, 676 | $8N_2$, 615 |
| | $13H_2$, 762 | $14N_2$, 712 |
| | $xH_2$, $526 + 18x$ | $xN_2$, $526 + 11x$ |

These results are compared with those obtained by previous investigators.

Although the addition to electrolytic gas of equimolecular proportions of hydrogen and nitrogen causes a greater rise in the ignition-point in the former case than in the latter, there are no grounds for assuming that a higher temperature is required to explode a mixture containing an excess of hydrogen than one containing a corresponding excess of nitrogen. It is concluded that the greater conductivity of hydrogen necessitates a greater compression or that the value of $\gamma$ must be different in the two cases, although equal values of $\gamma$ have been assumed in the calculations. Experiments with argon as a diluent are being undertaken to ascertain the effect of a gas of known specific heat. For the lowering of the ignition temperature caused by excess of oxygen no satisfactory explanation is advanced, but the increased activity of oxygen at the higher concentrations might be explained if oxygen formed an active polymeride under these conditions or if the concentration of the oxygen brought about ionisation of the hydrogen molecules. T. H. P.

**1856.** *Limits of Inflammability of Fire-damp.* **F. Leprince-Ringuet.** (Comptes Rendus, 158. pp. 1793–1796, June 15, 1914.)—By limit of inflammability the author understands the minimum percentage at which the inflammation is regularly propagated downward in a tube from the top to the bottom; he finds that the direction is important, the relative limits being: downward 5·76, horizontally 5·56, upward 5·20. Most of the experiments were made in 1910 already with gas from Taffanel's station at Liévin or with gas from the Lens colliery. In determining the composition of the gas it is necessary to remember that the gas collected in the mines is saturated with water-vapour, and that its composition therefore changes with the temperature. This is also to be considered when the analysis is made by the Lebreton apparatus, where the temperature, the percentage of water-vapour, and the solubility of the gases in the water with which they are shaken are to be determined. The author gives a formula for the limit which, he finds, is hardly influenced by the atmospheric pressure (753–797 mm.), but varies with the diam. of the tube, or rather with the diam. of the orifice. H. B.

**1857.** *Photographic Analysis of Explosions in the Magnetic Field.* **H. B. Dixon, C. Campbell, and W. E. Slater.** (Roy. Soc., Proc. Ser. A. 90. pp. 506–511, Aug. 1, 1914.)—At the suggestion of J. J. Thomson, the authors have repeated Dixon's experiments on the photography of the explosion-wave under such conditions as to determine whether the form of the wave could be modified by a magnetic field. Thomson had previously called attention to the fact that combustion is concerned not only with atoms and molecules, but also with electrons moving with very high velocities. In the "surface combustions" studied by Bone it appeared probable that the streams of electrons known to be emitted by incandescent surfaces promoted combustion by electrifying the contiguous layers of gas, and the great rapidity of combustion in the explosion-wave might be due to the molecules at the moment of combustion sending out electrons with very high velocities. These may precede the explosion-wave and prepare the way for it by ionising the gas. Now the motion of the ions can be stopped at once by means of a transverse magnetic field (in which they curl up and are caused to revolve in small circles), so that several attempts were made to detect the effect of a magnetic field on the propagation of an explosion-wave. A very complete description is given of the powerful magnets used, including two designed by Rutherford for the purpose of deflecting electrons of high velocity. The experimental details are very fully described, while sixteen photographs of explosion-waves through different gaseous mixtures are included; these latter were cyanogen and oxygen with different proportions of nitrogen, hydrogen, and oxygen, acetylene and oxygen, carbon disulphide and oxygen, and carbon monoxide with oxygen. In no case did the powerful magnetic field employed produce any visible effect, and since the mechanism of a compression-wave (liberating the chemical energy as it goes along) accounts in a reasonable way for the phenomena of gas explosions, the authors see no convincing evidence that the velocity of the explosion-wave is due to the ionising action of electrons. H. H. Ho.

1858. *Molecular Rotation-energy and the Quantum Theory.* **E[va] v. Bahr.** (Phil. Mag. 28. pp. 71–88, July, 1914.)—Nernst has pointed out [Abstract No. 900 (1911)] that, in dealing with molecular rotation, we must probably introduce the quantum hypothesis, since the rotation of a molecule—with charged atoms—causes radiation, and that, even with infinitely thick gas layers, we do not find any emission of the shorter waves. The authoress here summarises and discusses the bearing on this question of the most important results of recent investigations of ultra-red absorption by gases. The result strongly supports the assumption of discontinuity in the distribution of rotation frequencies. The cause of the effect of pressure on the absorption, which the authoress has done much to elucidate experimentally [Abstract No. 1946 (1913)], still remains unexplained. G. W. DE T.

1859. *Relation of Liquid Cohesion to Dielectric Capacity and Permeability.* **W. C. McC. Lewis.** (Phil. Mag. 28. pp. 104–116, July, 1914.)—The work of Perrin, Millikan, and Svedberg leads to the conclusion that the intervals between molecules in liquids are of the same order as the molecular diameters, a closeness of packing leading to the expectation of large values for the internal pressure or cohesion. E. Obach has noted [Phil. Mag. 31. Ser. 5. p. 118, 1891] an approximate proportionality between the latent heat of vaporisation of a liquid and its dielectric constant. Dupré suggested, long ago, that the latent heat of vaporisation of unit volume of a liquid is a measure of the internal pressure, and though certainly not exactly correct, large latent heat accompanies large cohesion. There should therefore be a rough proportionality between dielectric capacity and cohesion, as maintained by Walden [Abstract No. 862 (1910)]. Calculation from Young's data [Abstract No. 1785 (1910)] of the *minimal* values of the internal pressures of a large number of liquids at 0° C. confirm the Obach-Walden relation, which is here shown to follow from the assumption that the molecular attraction is electromagnetic, not electrostatic, in nature, with the further consequence that large internal pressure corresponds to small permeability. Pascal's relation, viz., that the product of magnetic susceptibility into specific volume is constant for a given substance, is shown to involve constant orbital velocity of the electrons. Bohr's assumption of constant angular momentum in conjunction with this would lead to the conclusion that the vibration-frequency of the visible and ultra-violet absorption bands should be the same for both liquid and vapour, a conclusion which is only approximately in accord with experiment. The effect of temperature in partially destroying orientation of the molecules appears to alter the inverse fourth-power law to the inverse cube, as expressed in Dieterici's equation $(p + a/v^{5/3})(v - b) = \mathrm{RT}$. [Abstract No. 80 (1900).] G. W. DE T.

# ELECTRICITY AND MAGNETISM.

## THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1860. *Ponderomotive Force on a Dielectric carrying a Displacement Current in a Magnetic Field.* **R. H. Goddard.** (Phys. Rev. 4. Ser. 2. pp. 99–120, Aug., 1914.)—According to Lorentz's theory of a dielectric, a ponderomotive force must act upon it when carrying a displacement current in a magnetic field, analogous to the force which is known to act upon a conductor when carrying a conduction current in a magnetic field. An experiment performed by Whitehead in 1902 gave a negative result, and this was shown to be in accordance with theory (Lorentz, Gans, Koláček). The author now develops a more general theory, which includes Whitehead's experiment as a special case, and further suggests an experiment by which a positive result should be obtained. A preliminary experiment with a piece of ebonite has given a ponderomotive form of the required order of magnitude. E. E. F.

1861. *Effect of the Magneton in Scattering of α-Rays.* **W. M. Hicks.** (Roy. Soc., Proc. Ser. A. 90. pp. 356–364, July 1, 1914.)—Treats mathematically the simple case of charged particles moving in the equatorial plane of a fixed magnetic doublet without taking account of a central nuclear charge. The orbit described depends upon the direction of approach. If this is originally along the axis of $x$ towards the doublet at the origin, the path is an equilateral hyperbola with the axes of $x$ and $y$ as asymptotes. Particles approaching towards one side of the magneton's centre are less sharply deflected, those approaching towards the other side of the centre may be turned back with or without one or more loops. These paths are plotted in two diagrams and their equations and properties fully calculated. E. H. B.

1862. *Electron Theory of Thermomagnetic Effect.* **H. Zahn.** (Phys. Zeitschr. 15. pp. 663–665, July 1, 1914.)—Discusses mathematically the simplifying assumptions and, with their help, obtains the coefficient of the thermomagnetic effect from the equations of the theory of Gans. [See Abstract No. 556 (1914).] E. H. B.

1863. *Electrification at Liquid-Gas Surfaces.* **H. A. McTaggart.** (Phil. Mag. 28. pp. 367–378, Sept., 1914.)—In continuation of his previous work [see Abstract No. 958 (1914)], the author has examined the velocities of bubbles of air in aqueous solutions of a number of alcohols, fatty acids, etc., and in a few pure alcohols. The results show that the addition of an alcohol to water reduces the electrification at the liquid-gas surface, the effectiveness of any alcohol in this respect corresponding with its effectiveness in reducing the surface tension of water. In the case of air-bubbles in pure alcohols, there appears to be no cataphoresis. The fatty acids diminish the charge at the gas-liquid surface in aqueous solutions, but no reversal was observed with the concentrations used. A marked variation of velocity with size of air-bubbles in cataphoresis experiments is produced by the presence in the aqueous solution of substances having a pronounced effect on the surface tension. Evidence is adduced to show that the electrification in water-fall experiments is not due to the difference of potential observed in the cataphoresis experiments. T. H. P.

1864. *On Some Sources of Disturbance of the Normal Atmospheric Potential Gradient.* **W. A. D. Rudge.** (Roy. Soc., Proc. Ser. A. 90. pp. 571–582, Sept. 7, 1914.)—The author has in the past made many observations on the effect of dust clouds on the potential gradient in Africa [see Abstracts Nos. 1182 (1913) and 886 (1914)]. More recently he has conducted experiments near to roads in Great Britain, and has found that the raising of dust by a passing vehicle has a pronounced, though transitory, effect upon the potential gradient. In the case of freshly-repaired sandy roads this effect may be in the direction of a reduction of the normal positive gradient, but with all old roads the disturbance takes the form of an increase of the positive gradient. This is ascribed to the presence of organic matter, which enters largely into the dust of a road that has been in use for any length of time. Manufacturing operations which produce much dust also have a very pronounced effect on the potential gradient. One hundred paces from a large Portland cement works the gradient was found to be + 880 volts/m., and this was not reduced to the normal value at the time in a free exposure, 70 volts/m. within 1000 paces of the works. Steam from passing trains has a very similar effect, the passage of each train being shown by a large rise in the gradient in the neighbourhood. It is thus demonstrated that purely local effects may have a large influence on the potential gradient. J. S. Di.

1865. *New Atmospheric-electric Instruments and Methods.* **W. F. G. Swann.** (Terrestrial Magnetism, 19. pp. 171–185, Sept., 1914.)—A serious fault in the well-known apparatus designed by Ebert for determining the number of ions per c.cm. of air is the length of the time over which the experiment must extend in order that a measurable fall in the potential of the inner charged rod may be produced. This potential is normally about 200 volts and the electroscope by which it is measured is not adapted to measure such a small fall of potential as would occur if the air current were allowed to flow through the apparatus for a few minutes only. The modification adopted by the author in order to overcome this difficulty consists in charging the outer cylinder of the apparatus to a high potential while the central rod is initially at zero potential. Small changes in the potential of this inner rod can then easily be measured and the time necessary for an experiment is materially reduced. Certain difficulties are introduced by the change of method, and modifications are included to overcome these. In the usual method of measuring the radio-active content of the atmosphere a wire charged to about 2000 volts below the earth's potential is freely exposed for a definite time in the air during which time it becomes more or less radio-active. The author points out that in the reduction of the observations the charge upon the wire during its exposure is of importance, and this charge depends amongst other things upon the potential gradient existing at the time and is thus difficult to determine accurately. It is proposed to maintain the potential of the wire at a constant value below that which the space occupied by the wire would have in the absence of the latter, instead of below the earth's potential; by this means the source of error introduced by variations in the potential gradient is overcome. A method by which this end may be achieved is set out. The last piece of apparatus described forms a novel method of measuring the potential gradient. If the position of an insulated body be moved in an electric field, its potential will change and the amount of this change will be proportional to the potential gradient in the field. The instrument described is based on this principle and is particularly suitable for use at sea, where the ordinary methods of measurement cannot be regarded as very satisfactory. J. S. Di.

## DISCHARGE AND OSCILLATIONS.

**1866.** *Volume Charge due to Positive Ions.* **W. Schottky.** (Phys. Zeitschr. 15. pp. 656–657, July 1, 1914.)—According to C. D. Child [Abstract No. 1208 (1911)] it takes about 10 volts to produce a current of 1 microamp. consisting of positive ions issuing from an electrode in a high vacuum. For electrons proceeding from thin wires to coaxial cylinders a law of the form $I = 2/9 \times (2\gamma)^{1/2}\Phi^{3/2}/R$ has been put forward and verified. The author shows that such a law is also approximately fulfilled in the case of positive ions proceeding from a carbon filament. E. E. F.

**1867.** *Origin of the Electron Emission from Glowing Solids.* **F. Horton.** (Roy. Soc., Phil. Trans. 214. pp. 277–294, Sept. 24, 1914.)—Recent researches on the negative ionisation from glowing solids have thrown doubt on the accuracy of the view of the origin of this ionisation which has been developed by O. W. Richardson. This view is based on the electron theory of metallic conduction, and supposes that an electron entering the surface layer with a normal velocity component greater than a certain amount is able to escape into the surrounding space and to take part in carrying the thermionic current. On this view, as Richardson has shown, the electron emission increases rapidly with the temperature, the connection between these qualities being given by an exponential formula, $i = A\theta^{1/2} e^{-\theta/2\theta}$, where $i$ is the thermionic current, $\theta$ the absolute temperature, and A and Q are constants. That this formula represents, with fair accuracy, the observed results in the case of platinum and of certain other substances for temperatures up to 1500° C. has been shown by the experiments of Richardson, by H. A. Wilson, by the author, and by other experimenters. Experiments made at higher temperatures, however, have generally shown that the current increases less rapidly with the temperature than is required by this formula. H. A. Wilson has further shown that the current measured at any temperature depends very largely upon the nature of the residual gas present in the apparatus. This has led to the view that the ionisation is entirely due to chemical action between these gases and the heated solid—a view which is also in agreement with the exponential relation between the current and the temperature, for such chemical changes as might occur would probably increase with the temperature in this manner. This chemical action theory has received considerable support from the experiments of Haber and Just, and of Fredenhagen on the alkali metals, and of Pring and Parker on carbon. Richardson has recently described some experiments with a tungsten filament heated to a high temperature in a good vacuum, and has considered the following different hypotheses as to the possible mode of origin of the electronic emission: (1) The emission is due to the evolution of gas by the filament. (2) The emission is caused by chemical action or by some other cause depending on impacts between gas molecules and the filament. (3) The emission is the result of some process involving consumption of tungsten. Experiments were devised for the purpose of testing each of these theories, and in each case it was found that the observed emission was very much greater than could be accounted for by the hypotheses. The view that the electron emission from glowing lime occurs as a result of the recombination of calcium and oxygen which have been liberated electrolytically has been put forward by Fredenhagen. In 1905 the author investigated the electric conductivity of lime at high temperatures and came to the conclusion that the conductivity is mainly carried on by electrons set free in the interior of the oxide, but that some electrolysis also occurs. Thus there is the necessary condition for the hypotheses as to the origin of the activity of a lime kathode put forward by Fredenhagen.

The experiments described in the present paper were performed to test the "chemical action" theory of the working of an oxide kathode. Fredenhagen experimented with a mixture of lime and magnesia, which is a better conductor than lime alone. The experiments here described were made with Nernst filaments which consist of a mixture of oxides having a much greater conductivity than the mixture used by Fredenhagen. It has been found by Owen that these filaments give a large electron emission at high temperatures. The following points have been investigated :—(1) Does the electron emission from a Nernst filament depend upon whether the heating current is alternating or continuous? We should expect that if the conduction through these filaments is electrolytic, the recombination of the constituents would be more complete with an alternating current than when a continuous current is employed; so that, if the electron emission depends upon this recombination, the thermionic current at a given temperature should be greater in the former case. (2) Is the emission from a Nernst filament the same when it is heated by conducting an electric current and when it is heated by a metal wire being raised to incandescence by an electric current? In the latter case practically the whole of the heating current is carried by the metal wire, and any electrolysis which occurs is due to the thermionic current; so that recombination must be very much less under these circumstances than when the filament itself conducts the heating current. (3) The emission from a Nernst filament heated in the ordinary manner has been compared with that given by the same material when powdered upon Pt. This experiment is similar to that just mentioned. These experiments show that the oxides of which these are made suffer electrolysis when conducting an electric current, but that the electron emission which occurs at high temperatures is not due either directly or indirectly to this electrolysis, for the magnitude of the emission at a given temperature is the same whether the current through the material is great or small. It is therefore concluded that the emission from lime in a Wehnelt kathode is not due to the recombination of electrolytically separated calcium and oxygen, as has been suggested. Owing to the increasing chemical activity of substances at high temperatures, and to the impossibility of removing all traces of impurities from the discharge tube, it is very difficult to prove conclusively that any known case of electron emission is purely a thermal effect; but, on the other hand, there is no satisfactory evidence that ionisation is ever produced by chemical action alone. It would seem, therefore, that the theory that thermal agitation is by itself sufficient to cause the emission of electrons from matter could only be disproved by reducing the thermionic current from a metal at the highest attainable temperature to zero. The increased ionisation from a glowing kathode which occurs when a chemically active gas is allowed to enter the discharge tube may arise in several ways: (1) It may be directly due to chemical action; (2) it may be indirectly due to chemical action, arising as a consequence of an increase of temperature resulting therefrom, or from the product of the action having a greater activity than the original substance of the kathode; (3) it may be due to an alteration of the surface conditions at the kathode in such a manner as to make it easier for the electrons to escape, for instance, by the formation of an electric double layer; (4) it may be due to ionisation by collisions.

It seems probable that the cause of the increased activity is different in different cases. A. E. G.

1868. *Emission of Ions by Non-radio-active Salts.* **D. Pacini.** (N. Cimento, 7. Ser. 6. pp. 267–290, May, 1914.)—Studies the ions emitted by ammonium sulphate and nitrate, potassium bromide, quinine sulphate, and a few other substances [see Abstracts Nos. 782 (1905), 1062 (1907)], and shows that the ions are probably due to some electrochemical action of water-vapour upon these salts. E. E. F.

1869. *Conductivity of Salt Vapours.* **S. J. Kalandyk.** (Roy. Soc., Proc. Ser. A. 90. pp. 634–647, Sept. 7, 1914.)—It has been shown by Beattie, Garrett [Abstract No. 1381 (1907)], and Garrett and Willows, that when certain salts are heated up to 300–400° C. the discharge of positive and negative electricity can be observed. This phenomenon is noticed more particularly in the case of the halogen salts of cadmium, zinc, and ammonium. The researches of Schmidt and Sheard [Abstract No. 1028 (1913)] have shown that the discharge is due to two factors: (1) emission of the charges from the surface of the heated salt, and (2) to the conductivity of the salt vapours themselves. The thermionic effect of the above-mentioned salts was studied in detail by O. W. Richardson [Abstract No. 182 (1914)] and his pupils, while some investigations of the electrical properties of the salt vapours was made by Schmidt in the papers referred to above. The object of the present research was to investigate the influence of the temperature, water-vapour, time, etc., on the current passing in the salt vapours. The special form of apparatus used is described in detail. The experiments described show that the conductivity of the salt vapours is due to the processes occurring in the vapours themselves. The vapours of carefully dried salts conduct the electric current. Therefore the conductivity cannot be ascribed to the chemical action of water-vapour on the salt vapours. However, the presence of water-vapour increases the current passing in salt vapours. When cadmium is very carefully dried, it is possible to observe a current which is practically independent of time. The connection between the current $i$ and the temperature $\theta$ may be expressed with considerable accuracy by the formula $i=ae^{-b/\theta}$, where $a$ and $b$ are constants. The ionising potential calculated from the energy of dissociation is considerably less than that for the ordinary gases. The dissociation of vapours is, however, not always accompanied by ionisation. A. E. G.

1870. *Theory of Ionomagnetic Rotations.* **A. Righi.** (Accad. Lincei, Atti, 23. pp. 897–906, June 21, 1914. N. Cimento, 7. Ser. 6. pp. 291–308, May, 1914.)—Gives a fuller theory of rotations produced by ions in a magnetic field [Abstract No. 131 (1914)]. In order that this theory may be more fully verified, it will be necessary to ionise the gas in some other way than by sparking. E. E. F.

1871. *Photoelectric Photometry.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 15. pp. 610–611, June 15, 1914.)—The rule according to which the photoelectric current of a potassium cell is proportional to the strength of illumination [Abstract No. 128 (1914)] is not strictly fulfilled in the case of very intense light, such as direct summer sunlight. With an accelerating voltage of more than 20 the current may rise from 8 microamps. to about 1 milliamp. This is due to shock ionisation in the low-pressure argon which fills the cell, as may be seen by the luminous discharge. The remedy is either to employ a very high vacuum or to stop down the aperture in a known ratio until the shock effect becomes negligible. In any case, the current should always be of an order not exceeding 1 microamp. E. E. F.

1872. *Secondary Radiation from Canal Rays on an Insulator.* **J. Koenigsberger** and **A. Gallus.** (Deutsch. Phys. Gesell., Verh. 16. 4. pp. 190–194, Feb. 28, 1914.)—The problem was whether during secondary radiation (the liberation of electrons on the impact of canal rays) there were any effects of affinity. The secondary radiation from metals was compared with that from a good insulator at an incidence of from 70° to 80°. The insulator was found to give far less secondary radiation than the metal. Positive canal rays gave about one-third the radiation set up by neutral canal rays. The diffuse reflection of canal rays is much the same with the insulator as with metals. The secondary radiation from brass corresponds, under the conditions of the experiments, to the liberation of from two to four electrons per atom caught in the incident canal rays. [See also Abstracts Nos. 905 (1912), 1184 (1913).] A. D.

1873. *Action of a Wehnelt Kathode.* **F. Horton.** (Phil. Mag. 28. pp. 244–252, Aug., 1914.)—In a previous paper the author gave reasons for supposing that the activity of a Wehnelt kathode is not due to an escape of electrons from the molecules of lime simply as the result of an increase in their thermal energy. The presence of the electronegative oxygen atom in the lime molecule would hinder the escape of electrons so that we should expect to get a greater emission from pure calcium on Pt than from lime; the reverse, however, was found to be the case. Experiments have now been made to compare the activity of lime on Pt with that of lime on a Nernst filament. Within the limits of experimental error these are the same, so that the electron emission has its origin in the lime itself, and the lime does not merely serve to help the electrons to escape from the metal. Fredenhagen has suggested that the electron emission arises from the recombination of Ca and O liberated electrolytically; A. Gehrts [see Abstract No. 125 (1914)] gives a modification of this view to the effect that the separation of Ca and O is caused not by electrolysis but by thermic dissociation. To test these theories experiments were made upon the gas liberated from the lime. These reveal the fact that the amount of oxygen liberated is only a very small fraction of what would be expected if the conductivity of the lime were entirely electrolytic. Further, it was found that the chemical combination of Ca and O does not of itself give rise to any detectable electron emission, so that it appears that the theories of Fredenhagen and Gehrts cannot be accepted as an explanation of the activity of the Wehnelt kathode. F. J. H.

1874. *Disintegration of the Aluminium Kathode.* **L. L. Campbell.** (Phil. Mag. 28. pp. 347–354, Sept., 1914.)—The aluminium kathode in discharge-tubes has been supposed not to disintegrate to any marked extent, except in the monatomic gases. The author has undertaken a preliminary investigation to find if the aluminium kathode disintegrates in the presence of Cl and of other gases. It was found that it does "splutter" violently in the presence of the halogens, certain metallic vapours and other gases. The disintegration of the kathode seems to take place best when the pressure in the tube has reached the ordinary X-ray stage, and when the kathode dark-space has reached the walls of the tube next the kathode. The rate of disintegration seems to increase in general with the molecular weight of the discharge gas. It seems probable that under proper conditions the Al kathode will disintegrate in all gases more or less rapidly. J. J. S.

1875. *Potential to Maintain Current between Coaxial Cylinders.* **J. S. Townsend.** (Phil. Mag. 28. pp. 83–90, July, 1914.)—The potential required to start a discharge between a wire and a large coaxial cylinder has a definite value $V_0$, and the rise $V-V_0$ required to maintain a given current has been found experimentally. For small currents, $V-V_0$ is proportionate to C, the current per unit length of wire, and the author has given a simple formula connecting them [Abstract No. 1882 (1913)] obtained by assuming the ions to be produced from molecules of the gas by collisions within a short distance of the wire, where the electric force is large. C affects the field of force owing to the charge from ionisation in the gas, chiefly from ions of the same sign as the charge on the wire. The volume distribution so arising tends, during current flow, to diminish the electric force near the surface of the wire. Thus, to maintain the current the p.d. between wire and cylinder must be increased. A relation between V and C is then obtained by assuming the electric force at the surface of the wire to be that corresponding to $V_0$ and that the velocities of the ions are proportional to the electric force. The latter is not true for negative ions moving in gases at low pressures, but the resulting formula, when compared with experimental results, shows very clearly many properties of the negative ions. G. W. DE T.

1876. *Discharge of Electricity from Points.* **P. J. Edmunds.** (Phil. Mag. 28. pp. 234–244, Aug., 1914.)—The author has previously shown in conjunction with J. S. Townsend [Abstract No. 1595 (1914)] that if V be the p.d. necessary to cause a discharge to pass between two conductors through a gas at pressure $p$, then if the linear dimensions are reduced in the ratio $1/k$, the same potential will be required for a gas pressure of $kp$. This relation was found to be valid for concentric cylindrical electrodes. Measurements of a similar character have now been made for discharges from hemispherically pointed wires to a plane, with identical results. A considerable "lag" between the application of the potential and the passage of the discharge was experienced. In the final measurements this was overcome by the presence of a weak ionising agent which was found not to cause any change in the value of the sparking potential. Dealing with the problem theoretically the author has succeeded in developing an approximate formula connecting the potential required with the dimensions and gas pressure. For the smaller wires the calculated values lie between those found experimentally for positive and negative charges; the agreement for the larger points although of the right order is not so good. The connection between the electric intensity at the vertex of the point and the radius is found to be $f\sqrt{a}=60$, where $f$ is in electrostatic units and $a$ in cm. This is in good agreement with $f\sqrt{a}=56{\cdot}9$ found empirically for liquid points by Zeleny [Abstract No. 1108 (1914)].

F. J. H.

1877. *Distinction between the Spark Discharge and the Arc.* **A. Occhialini.** (N. Cimento, 7. Ser. 6. pp. 365–378, June, 1914.)—The first part of the paper is concerned with showing that the spark is the initial stage of the discharge, the final being an arc. The arc takes place when the electrode can rise sufficiently in temperature to emit a copious supply of ions. By examining the discharge by the rotating mirror method, using a solution as one electrode, the arc stage is suppressed, the "pilot" only being present. If the discharges are examined spectroscopically, the pilot gives a line spectrum. But on using metallic electrodes the arc spectrum has bands. The two discharges become similar in form if the self-inductance of the circuit is reduced to a minimum.

In the second part a method of producing oscillations in an arc, without the use of capacity or inductance, is described. The two arc electrodes A and B are maintained respectively at 0 and 110 volts, while a third electrode C at right angles to the other two is maintained at —110 volts. The arc takes place between B and C, but a magnetic field parallel to AB drives it on to AB. Oscillations in both circuits are found to occur, and these are examined by means of the oscillograph. S. G. S.

## ELECTRICAL PROPERTIES AND INSTRUMENTS.

1878. *Wave-length-sensibility Curves for Selenium.* **F. C. Brown** and **L. P. Sieg.** (Phys. Rev. 4. Ser. 2. pp. 48–61, July, 1914.)—An analysis of sensibility curves in terms of wave-length of incident light requires at least two separate light actions in the selenium. Knowing that the structure of light-sensitive Se is complex, and knowing what we do about the nature of this complexity, we should now perhaps be in a position to apply the electron theory to an explanation of the phenomenon. The double refraction shown by some Se crystals is of importance, for crystals which are directive towards light should also be directive in their electrical properties. Light probably does not act on the Se atoms as units. Rather a large unit, say a crystal unit, is the seat of the disturbance by light action. Crystal boundaries must be recognised when dealing with the flow of electrons in Se, and possibly also in other elements. E. E. F.

1879. *Properties of Selenium.* **F. C. Brown.** (Phys. Rev. 4. Ser. 2. pp. 85–98, Aug., 1914.)—The author produced a great variety of Se crystals, some of them very large. Nearly all showed a marked selective transparency, a large amount of light penetrating to a depth of 0·2 mm. All the forms tested were found to be conducting, the specific conductivity varying from 200 to $10^7$. All but one proved to be doubly refracting, and in every crystal the conductivity increased on illumination. The light acts in the Se itself and not at the contacts. The conductivity may be increased 1000 times by pressure, and the change of conductivity on illumination is always proportional to the conductivity in the dark. The temperature at which the crystals sublimate in mass influences the character of the wave-length-sensibility curves. The study of individual Se crystals is free from many of the difficulties presented by Se bridges. E. E. F.

1880. *Influence of Tellurium on the Light-sensitiveness of Selenium.* **Abonnenc.** (Comptes Rendus, 159. pp. 41–43, July 6, 1914.)—Selenium "bridges" with carbon electrodes were made of purified Se to which from 1 to 7 % of tellurium had been added. The various specimens were exposed to light filtered through colour screens, and the relative conductivities noted. The Te produced in general a reduction of the sensitiveness, but an increased sensitiveness to red light, which was granted with a 1 % addition. E. E. F.

1881. *Evidence for Electron Atmospheres.* **F. F. Householder.** (Phys. Rev. 4. Ser. 2. p. 47, July, 1914.)—Wood's observation [Abstract No. 865 (1913)] that narrow cuts across a silver film do not materially interfere with its conductivity was taken as evidence for an atmosphere of electrons extending about one sodium wave-length (0·6 $\mu$) from the silver atoms. The author has repeated this experiment with much narrower strips and examined them with a microscope magnifying 1500 diameters. Metallic bridges were found wherever the conductivity was practically unaffected. But when the rulings were clear of bridges, the resistance exceeded 100 megohms. The conclusion is that if the electron atmospheres exist they do not extend farther that 0·15 $\mu$. E. E. F.

1882. *Electrical Conduction at High Temperatures.* **E. F. Northrup.** (Amer. Electrochem. Soc., Trans. 25. pp. 373–390; Discussion, pp. 390–392, 1914.)—The paper is chiefly a *résumé* of the results of measurements by methods which the author has already published [see Abstracts Nos. 491B and 1123A (1914)] of the resistivity at high temperatures of the metals, Na, K, Hg, Cd, Pb, Zn, Sn, Bi, Sb, Cu, Al, Ag, and Au; also of the alloys Na-K and brass. Curves are given which display the following features: A change of state is always accompanied by an almost sudden change in resistivity. For metals which expand on liquefaction the resistivity a little more than doubles. For both Bi and Sb which contract, it diminishes. With the exception of Zn, Cd, and Sb, the increase in resistivity with temperature is very nearly linear when the metals are molten, and may be used to measure with precision a high temperature in a laboratory furnace. With at least six pure metals the resistance coefficient is closely connected with the coefficient of expansion, the ratio of the two coefficients being approximately a constant quantity. This suggests that with increasing temperature the increase in resistivity is closely associated with the increase in the distance between the atoms or molecules. Insulators decrease in resistivity very rapidly with increase of temperature, so much so that at 1600° C., or over, the insulators have a resistivity of the same order of magnitude measured in ohms as the molten metals have measured in microhms. In the *discussion*, **J. W. Richards** pointed out a connection between the ratio of resistivities in the molten and solid states, the melting-point, the atomic weight, and the latent heat of fusion. F. J. H.

1883. *Electrical Resistance and Critical Ranges of Pure Iron.* **G. K. Burgess** and **I. N. Kellberg.** (Washington Acad. Sci., Journ. 4. pp. 436–440, Sept., 1914.)—The resistance of an iron wire and one of Pt wound on the same support and enclosed *in vacuo* in a quartz tube have been compared every few seconds during both heating and cooling. The results show that the resistance of iron increases with a gradually increasing temperature-coefficient as the temperature rises from 0° C. to above 650° C. As A2 is approached, there is a rapid rise in the resistance-temperature curve, culminating in a cusp at 757° in the temperature-coefficient curve. At Ac3 the resistance falls rapidly, but the decrease is recovered within an interval of 25 deg. C. On cooling the reverse phenomena are observed. It appears, therefore, that A2 is a strictly reversible transformation, and that A3 is a transformation taking place at a higher temperature on heating than on cooling. These results are in agreement with the thermal results described in Abstract No. 1003 (1914), but whether both A2 and A3 are to be regarded as allotropic points will depend on the precise definition of allotropy. The behaviour at A2 appears to be similar to that of a pure substance at its melting-point, while at A3 there are progressive changes in the electrical and thermal properties which are not reversible. A2 is the temperature associated with the abrupt reversible change of iron from the ferromagnetic to the paramagnetic state, but no crystallographic change has yet been observed at this temperature. The A3 point is, however, certainly associated with a change in the crystallographic state. F. C. A. H. L.

1884. *Contact Difference of Potential of Distilled Metals.* **A. L. Hughes.** (Phil. Mag. 28. pp. 337–347, Sept., 1914.)—The contact p.d. between metals was investigated, and particularly its relation to the presence or absence of occluded gases. The result of the experiments showed that the contact potential between metals under ordinary conditions depends to a very great extent upon the gas absorbed in the surface. The contact p.d. between Zn and Bi, both distilled *in vacuo*, and Pt, was measured. Initially there is but little contact difference of potential between the distilled metal and platinum, but the admission of a trace of air into the vacuum causes a great increase in the contact p.d. The change occurs at the surface of the distilled metal which becomes more electropositive. A maximum is reached, after which the contact p.d. decreases to a steady value that is scarcely affected by the presence or absence of air. It is not possible at present to say whether the effect is due to mere absorption of the gas or to something of a more definite chemical nature. J. J. S.

1885. *Volta-effect.* **J. Guyot.** (Comptes Rendus, 159. pp. 307–311, July 27, 1914.)—If the apparent difference of potential at the contact of a metal and distilled water is measured and then at the surface of the water extremely slight traces of certain insoluble organic substances be deposited, the apparent p.d. is found to diminish very notably, and may even become inverted. When a very dilute solution of triolein in pure benzene of commerce was added drop by drop on a surface of water, the diminution of the Volta-effect occurred very rapidly at first, even before the free surface of the water was entirely covered by oil molecules. It is almost terminated when the substance deposited forms a monomolecular layer, although then, according to Rayleigh's experiments, the surface tension is still equal to that of pure water. On adding more drops a rapid lowering of the surface tension is produced whilst the diminution of the Volta-effect proceeds more slowly and attains finally a limiting value. The variation of the apparent p.d. precedes the variation of the surface tension, and there does not appear to exist a simple relation between the capillary constant and the difference of potential which occurs at the free surface between air and water covered by a thin layer of organic substance. The greater part of the substances used were placed on the water in a solution in benzene, but experiment indicates that the solvent does not intervene, and that the limiting values of the lowering of the Volta-effect are characteristic of the substances spread over the water, directly or by means of a volatile solvent. Tables are given of the limiting values of the lowering of the Volta-effect at ordinary temperatures with various organic substances employed. That for triolein, for example, is 0·330 volt. J. J. S.

1886. *Pyro-electricity and the Quanta Theory.* **S. Boguslawski.** (Phys. Zeitschr. 15. pp. 569–572, June 1, 1914.)—To explain pyro-electricity, it is assumed that the displacement $x$ of a charge from its equilibrium position in a solid corresponds to an amount of work given by $ax^2 + bx^3$. In carrying out

the calculation according to the ordinary statistical mechanics, the result does not agree with experiment at low temperatures. An agreement is, however, obtained by using the quantum theory. The author compares his formula with Ackermann's figures for red tourmaline. The agreement is good, except below 100° abs. and above 500° abs. The outstanding deviations are attributable to the "pseudo"-pyro-electricity indirectly due to heat.
E. E. F.

1887. *Mercury Rectifiers.* **W. Jaeger.** (Archiv f. Elektrotechnik, 2. pp. 418–430, 1914. Communication from the Physikal.-Techn. Reichsanstalt.)—The behaviour of mercury rectifiers is theoretically studied for various combinations with resistances, capacities, and inductances. Sine currents are assumed, and the minimum e.m.f. is taken into account. The chief cases dealt with are: mercury valve in series with resistance and inductance; valve in series with resistance, and in parallel with inductance; capacity or resistance in parallel with valve. Special attention is devoted to the practically important question of the enlargement or reduction of the zone of transmission. The equations obtained are illustrated by diagrams.
E. E. F.

1888. *Potassium Photoelectric Cells.* **H. E. Ives.** (Astrophys. Journ. 39. pp. 428–458, June, 1914.)—A detailed investigation is made of the construction and behaviour of potassium photoelectric cells with a view to their use for photometry. Full practical instructions are given for their preparation. The investigation, carried out mainly by means of a quadrant electrometer, shows that the relation between illumination and current is not linear, but is a complicated function of voltage, electrode distance, and pressure, as is the relation between current and voltage. It is concluded that gas-filled photoelectric cells do not possess the qualities more desirable in a physical potentiometer.
E. E. F.

1889. *Testing of Potentiometers.* **F. Wenner** and **E. Weibel.** (Washington Acad. Sci., Journ. 4. pp. 469–471, Oct. 4, 1914. Paper read before the Amer. Physical Soc. Electrical World, 64. p. 874, Oct. 31, 1914. Abstract.)—The errors of a potentiometer can be determined by measurements of the resistances of the various sections, but without some systematic method of applying corrections they are not easily allowed for in the use of the potentiometer. In order to reduce the time required for making the measurements and to obtain the data in such form that the corrections can be more easily calculated, a special "ratio-set" equivalent to 211,110 resistance sections of 0·01 ohm each, has been constructed. In use the ratio-set is connected in parallel with the potentiometer to be tested in such a way as to form 2 arms of a bridge, while the potentiometer forms the other 2 arms, the arrangement constituting a Matthiessen and Hockin bridge.
F. E. S.

1890. *Primary Mercurial Resistance Standards.* **J. Obata.** (Mathematico-Physical Soc., Tōkyō, Proc. 7. pp. 346–354, July, 1914.)—Five new mercury standards of resistance have been constructed at the Electrotechnical Laboratory, Tōkyō. The tubes were calibrated with 2-cm. and 5-cm. mercury threads; the end planes of the tubes were polished optically flat; the contained mass of mercury determined by the Reichsanstalt method; and the resistances were compared by the modified Wheatstone bridge method suggested by the National Physical Laboratory. The tubes used are of Jena $16^{III}$ glass, are annealed, but do not appear to have been straightened.

The calibre factors of the 5 tubes are as follows: 1·000021, 1·000051, 1·000052, 1·000079, and 1·000093. The longest tube is 99·6 cm. and the shortest is 79·8 cm. The mean value of 4 manganin coils at 20° C. in terms of these 5 mercury resistances is $1{\cdot}00008_3$ int. ohms and the mean value of the same coils in terms of 5 mercury resistances made at the National Physical Laboratory is $1{\cdot}00007_5$ int. ohms. F. E. S.

## ALTERNATING CURRENTS AND MAGNETISM.

1891. *Preparation of Alloys for Magnetic Research.* **J. de Freudenreich.** (Archives des Sciences, 38. pp. 36–45, July, 1914.)—The alloys dealt with are those of Fe with Ni and Co. Referring to the fact that ferro-cobalt has a 9 per cent. superiority over iron when saturated, the measure of the saturation intensity of the alloy is taken as a convenient criterion of the success of the operation. The method of measuring the saturation intensity having been described [Abstract No. 995 (1910)], alloys were first produced by the aluminothermic or thermit method of heating. This gave specimens which were only 6·9 per cent. better than the standard iron, a result ascribed to the impurities unavoidably present. The method finally adopted was that of the electric furnace. The metal was melted within a carbon tube raised to about 2000° C. by a current of 2000 amps., and two blocks of 20 kg. were cast of which the second alone was serviceable. G. E. A.

1892. *Thermal and Magnetic Effects in Iron, Nickel, and Cobalt at High Temperatures.* **K. Honda.** (Sci. Reports, Tôhoku Univ., Sendai, 2. No. 2. pp. 69–94, 1913.)—Employing the Roberts-Austen differential method, a notable thermal effect was observed in iron, nickel, and cobalt during the magnetic transformation, and in all cases the thermal effect (smallest in annealed Co) takes place within a wide temperature interval. In iron and nickel, the initial temperatures of the magnetic change during cooling, and the final temperatures during heating, coincide with the corresponding temperatures of the thermal effect. During cooling, the evolution of heat stops at a much lower temperature than the magnetic change; during heating, the thermal effect also begins at a lower temperature. With a given field, the magnetic change takes place within definite limits of temperature, but the thermal effect is independent of the field. In weak fields the magnetic transformation in iron, steel, and nickel takes place within a small interval of temperature, but increase of the field causes a great increase in the temperature interval. In steel, the course of the intensity-temperature curve is interrupted by the eutectic change, the discontinuity being greater, the greater the amount of the eutectic. In pure iron, the $\beta$–$\gamma$ change takes place at a definite temperature; in steel, the change takes place over a range of temperature. The initial temperature of this change during cooling diminishes with increase of carbon, the lower limit of the change being the temperature at which the eutectic separates out. The thermal effect at the $\alpha$–$\beta$ change begins, for all steels, at about the same temperature, and extends to the temperature of eutectic separation. The author expresses his views with regard to the $\alpha$–$\beta$–$\gamma$ changes [see Abstract No. 1133 (1914)]. The paper is profusely illustrated with curves. G. E. A.

1893. *Compensated Electromagnet as Standard of Field Strength.* **R. Beattie.** (Electrician, 73. pp. 929–930, Sept. 18, 1914.)—A compensated electromagnet has been found to be convenient and reliable as a secondary standard of field strength or of flux. An opposite flux is imposed on the main flux in the magnet air-gap by means of an auxiliary series winding, the number of turns of which is so adjusted that the compensating flux increases or decreases with changing current at the same rate as the main flux. This is carried out by means of an electromagnet with a double external magnetic circuit each part having its own air-gap. The proper number of auxiliary turns was found by trial, and there was no special difficulty in getting the field in the gap constant to 1 or 2 in 1000 over a range of variation in the exciting current of 100 per cent. or more. With a suitable winding the magnet could be connected up to an ordinary lighting circuit. G. E. A.

1894. *Magnetic Transformation and its Nomenclature.* **K. Honda.** (Phys. Zeitschr. 15. pp. 705–707, July 15, 1914.)—As a rule physicists have looked on the transformation as a gradual process, whereas many metallurgists have assumed it to be a phase change which took place at a definite temperature. The author refers to the views of le Chatelier, Weiss, and Benedicks, and to his own, expressed recently. Taking the main facts of experiments, it can be concluded that in the temperature interval of the magnetic transformation of ferromagnetic substances an intermolecular change takes place which increases with temperature. The change in magnetisation and the heat phenomenon connected with it are the consequences of this change. This view is supported by the experiments of Charpy and Grenet [Abstract No. 1197 (1903)], of Broniewski [Abstracts Nos. 1498, 1542 (1913)], and of Honda and Ogura [Abstract No. 1133 (1914)]. In conclusion, the author considers that, as the temperature of magnetic transformation is the end temperature of that change, the term "critical point" originally given by Hopkinson is the most suitable one to apply to this temperature. G. E. A.

1895. *Susceptibility of the Binary Alloys.* **K. Honda** and **T. Soné.** (Sci. Reports, Tôhoku Univ., Sendai, 2. No. 1. pp. 1–14, 1913.)—The present paper, besides dealing with Sb-Bi and Sb-Zn [see Abstract No. 872 (1913)], gives also the susceptibility and melting-point curves for Sb-Al, Sb-Ta, Zn-Te, Zn-Pb, and Bi-Te. The susceptibility of the chemical combination of two metals cannot be deduced from those of the components. G. E. A.

1896. *Thermomagnetic Property of Magnetite.* **H. Takagi.** (Sci. Reports, Tôhoku Univ., Sendai, 2. No. 3. pp. 117–120, 1913.)—The susceptibilities of two specimens of natural magnetite are measured for the temperature range 600°–900°, and the curves for $\chi$ and $1/\chi$ with temperature are compared with those of Weiss and Foëx for artificial magnetite. It is concluded that Curie's law is only roughly satisfied, and that there is no internal change of state during heating and cooling. [See Abstracts Nos. 581 (1911), 699 (1913), and 856 (1914).] G. E. A.

1897. *Thermomagnetic Properties of some Elements.* **K. Honda** and **T. Soné.** (Sci. Reports, Tôhoku Univ., Sendai, 2. No. 1. pp. 27–31, 1913.)—The susceptibility at different temperatures of carbon in the form of diamond, of sulphur in various forms, of manganese and other elements was measured, and the results are exhibited in curves. The curve of the change of susceptibility with temperature of Ceylon graphite is also given. For diamond, graphite, sulphur, manganese, and osmium the susceptibility was independent of the field strength. For Er, Rb, and Se the susceptibility depended on the strength of field. The two diamonds examined had the forms of an octahedron and a rhombic dodekahedron, and the susceptibilities at ordinary temperatures were $\chi \times 10^6 = -0{\cdot}438$ and $-0{\cdot}452$. The susceptibility was independent of the orientation of the crystal. This constant had a value in powdered sulphur and in roll sulphur somewhat smaller than in crystallised sulphur. Some peculiarities in manganese and in graphite were perhaps due to the presence of iron. J. J. S.

1898. *Magnetic Susceptibility of Soils and Sands.* **H. Takagi.** (Sci. Reports, Tôhoku Univ., Sendai, 2. No. 1. pp. 15–24, 1913.)—The susceptibility of numerous samples of soils and sands from various places in Japan was measured, and the results are given in a series of tables and curves showing the value at different temperatures. In all the specimens the susceptibilities rapidly decreased with increasing temperature, and became very small between 580° and 600°. It seems very probable that the relatively strong magnetic constituents in soils and sands are the iron compounds. On gradually cooling from the highest temperature attained a reversible change of susceptibility with respect to temperature occurred. J. J. S.

1899. *Susceptibility and Density of Paramagnetic Substances.* **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Proc. 23. pp. 110–122, July 3, 1914. Supplement No. 36c to Communications from the Physical Lab., Leiden.)—The expression from the author's last paper [see Abstract No. 343 (1914)] for the molecular rotatory energy of a system of freely rotating molecules is employed to show that the susceptibility of oxygen in liquid mixtures of oxygen and nitrogen as well as that of liquid oxygen can be represented, within the degree of accuracy of the observations, with the aid of the application of the quantum theory to paramagnetism. The parameter $\theta_0$, called the characteristic zero temperature, is connected with the higher densities by the law $\theta_0 = a\rho^{2/3}$, where $a$ is constant for a definite substance. [See also Abstract No. 1142 (1914).] G. E. A.

1900. *Magnetic Study of Iron Sesquioxide.* **R. Wallach.** (Comptes Rendus, 159. pp. 49–51, July 6, 1914.)—The author has studied the magnetic properties of the following different varieties of ferric oxide: I, prepared by precipitating a warm, freshly-made and very dilute solution of ferric chloride with ammonia; II, Péan de Saint-Gilles' oxide, which is obtained from the above by boiling in water; and III, the oxide produced by the action of water on sodium ferrite, obtained by calcining the precipitated oxide with soda at a dull red heat. By the aid of the Curie-Chéveneau magnetic balance a study has been made of the variations in the susceptibility at temperatures between 15° and 1000° C. The susceptibility of the precipitated oxide at first increases with the temperature, the curve showing a break at 120° and a maximum at 200°. The value then falls rapidly to 300°, then more slowly until it reaches a minimum at 650° C., after which it rises slowly. The Péan oxide curve shows a continual fall, which becomes very rapid between 200° and 350°, at which temperature it joins the first curve. The curve of the ferrite oxide is very similar to the first curve, except that the absolute values are considerably higher. Heating curves taken with the Saladin galvanometer show absorptions of heat at 130° to 150° owing to the removal of water. Oxides I and II show evolutions of heat at 400°, the critical point of II being much less marked than that of I. In the ferrite oxide, however, the evolution does not occur until a temperature of 700° C. has been reached. In common with other ferromagnetic materials the diminution of the susceptibility is almost complete before the transformation has taken place, but in this case the change is irreversible. It has also been found possible to render the oxides much more magnetic by thermal treatment just in the same way as it is possible to effect a passing change in the susceptibility. F. C. A. H. L.

**1901.** *Rôle of Valency in the Additivity of Diamagnetism.* **P. Pascal.** (Comptes Rendus, 159. pp. 429–431, Aug. 17, 1914.)—The atomic coefficients of diamagnetism for mercury, lead, and tin in organo-metallic compounds vary from maximal values in the lower compounds to minimal ones—virtually identical with the values for the pure metals themselves—in the higher compounds of the series. In plumbic salts the value for the metal is practically equal to this lower limit, whereas in plumbous salts the value is nearly coincident with the upper limit. In stannous sulphate the value for tin is about equal to the minimal value. In halogen salts, such as stannic chloride, the coefficient of specific magnetisation is diminished by $0{\cdot}0237 \times 10^{-6}$ for each atom of halogen in the molecule. Mercury exhibits the same atomic coefficient in mercuric as in mercurous salts, this differing markedly from that of the pure metal but being approximately that derived from the initial terms of the organo-mercury series. It would seem, indeed, that mercury is divalent in mercurous salts, these giving rise to the divalent ion, $Hg_2$. These results are in accord with those of Baker on the vapour densities of dry mercurous chloride [Chem. Soc., Trans. 77. p. 646, 1900] and with those of Ogg on the kinetics of the reduction of mercurous and silver salts by mercury [Abstract No. 852 (1899)].

The neighbourhood of several halogen atoms round a central atom depresses the diamagnetism, owing to the action of supplementary valencies. T. H. P.

**1902.** *New Method for Magnetic Determinations.* **A. Schuster.** (Terrestrial Magnetism, 19. pp. 19–22, March, 1914.)—With the modern development of accurate measurement of electric currents, experiments have been made to determine if magnetic forces can be measured by using artificially prepared magnetic fields for standards of comparison. An instrument has been designed and a number of trials made at the National Physical Laboratory, the result being quite in favour of the method. A standard instrument is to be constructed to allow of a rigid comparison of the accuracy attainable, but in the preliminary work it was found possible to obtain readings of H showing changes remaining practically parallel with the diurnal variation. The saving of time will be one of the chief attributes of the new method. C. P. B.

**1903.** *Moon's Influence on Terrestrial Magnetism.* **S. Chapman.** (Terrestrial Magnetism, 19. pp. 39–44, March, 1914. Abstract of paper read before the British Assoc. at Birmingham, 1913.)—Although of minute amount, it is found that certain variations of the barometric pressure and the earth's magnetic field are to be ascribed to the influence of the moon. Thus, for instance, the magnetic variations are greater at times of perigee than at the apogee, there being also some evidence that the ratio of the amplitudes at the two periods is equal to the ratio of the corresponding values of the moon's tide-producing force. At any particular phase of the moon it has been found that the effect of the variable electrical conductivity of the upper air, in conjunction, with the simple semi-diurnal atmospheric oscillation, is to produce magnetic variations of frequency 1, 3, 4, etc., per day, in addition to the normal 2 periods per day. Further, the epochs of the various components undergo regular changes during the course of the lunar month, all being equal at new moon. These changes with the position of the sun confirm the hypothesis of a variation in the electrical conductivity of the upper air, depending on the solar hour angle. C. P. B.

**1904.** *The 27-day Period in Magnetic Phenomena.* **C. Chree.** (Roy. Soc., Proc. Ser. A. 90. pp. 583–599, Sept. 7, 1914.)—The author has shown previously [see Abstract No. 349 (1914)] that since 1890 there has been a decided tendency for the magnetic character of a day, whether disturbed or quiet, to resemble that of a day either 27 days earlier or 27 days later more closely than it does that of the average day. The magnetic character of a day is expressed on the scale 0 (quiet), 1 (moderately disturbed), 2 (highly disturbed). In the present paper the tendency to the 27-day period is examined by discussing the daily ranges at Kew of declination (D), horizontal force (H), and vertical force (V) on the five most disturbed and the five "quiet" days of each month from 1890 to 1900, instead of discussing the character figures of the days, which were employed previously. The method first employed is as follows:—If $n$ is a representative selected day, disturbed or quiet, the percentages of the mean amplitudes are obtained for the amplitudes of each of the components D, H, and V, on each of the days $n-2$, $n-1$, $n$, $n+1$, $n+2$; $n+25$, $n+26$, $n+27$, $n+28$, $n+29$, $n+30$. The results are set out for each year and for the whole period, and for each component, with reference both to disturbed and quiet days; and in a final table the means of the three components are given for the individual years and the whole period. The following average values are quoted:—

PERIOD 1890–1900: MEANS OF D, H, AND V RANGES.

*Percentages of Mean Absolute Daily Ranges.*

| $n-2$ | $n-1$ | $n$ | $n+1$ | $n+2$ | $n+25$ | $n+26$ | $n+27$ | $n+28$ | $n+29$ | $n+30$ |
|---|---|---|---|---|---|---|---|---|---|---|
| *Days of Largest Range and Associated Days.* | | | | | | | | | | |
| 103·6 | 134·4 | **189·7** | 129·9 | 107·7 | 100·4 | 108·1 | **115·2** | 113·6 | 108·1 | 106·3 |
| *Quiet Days and Associated Days.* | | | | | | | | | | |
| 91·2 | 80·5 | **69·7** | 89·8 | 103·8 | 93·7 | **88·9** | 89·9 | 92·0 | 95·5 | 98·0 |

These figures suggest a "period" slightly longer than 27 days in the case of disturbed days, and slightly longer than 26 days in the case of quiet days.

The matter is also considered by noting the number of times that the selected disturbed or quiet days are separated by intervals of 27 or 28 days, but a difficulty enters in of deciding which disturbances form such sequences and which do not, and renders this method less trustworthy than the former method outlined above. R. C.

**1905.** *Time Measurements of Magnetic Disturbances.* **C. Chree.** (Phys. Soc., Proc. 26. pp. 137–158; Discussion, p. 158, April, 1914.)—The discussion was introduced by Bauer, who considered the records provided evidence that a definite interval was occupied in the movement of magnetic disturbances to different parts of the earth's surface. Later Faris discussed the records of 15 magnetic disturbances, his conclusion being in support of Bauer's theory that the velocity of propagation was of the order of 100 km. per sec.

Chree's view was that the results can only be satisfactory when observations are secured from a number of stations encircling the earth, and Bauer then collected data from 80 stations. The analysis of the horizontal force curves from these, by Angenheister, proved unfavourable to Bauer's view.

The present paper deals with the material by a different method, and utilises the declination and vertical force curves in addition to those of horizontal force. The results bring out peculiarities which may be due to instrumental peculiarities, and emphasise the need of magnetic observatories being equipped with similar instruments, which should be capable of keeping records to a tenth of a second. C. P. B.

## RADIOLOGY AND ELECTROPHYSIOLOGY.

**1906.** *Visual Sensation caused by a Magnetic Field.* **C. E. Magnusson** and **H. C. Stevens.** (Phil. Mag. 28. pp. 188–207, Aug., 1914.)—The chief results of the author's former work are briefly summarised. The purpose of this paper is to present the results of experiments which aimed at the solution of a single problem, viz. the dependence of the threshold of the light sensation upon the frequency of the current. Knowing the relatively simple law which W. Nernst and his pupils found to exist between the minimal effective stimuli of alternating currents of high frequency and the intensity of the current, it is hoped to discover a similar simple relationship between frequency of alternation of the magnetic field and the minimal effective intensity of current just sufficient to cause the sensation of light. Nernst's law, $K = i/\sqrt{f}$, where K is a constant, $i$ the minimal intensity of current just sufficient to excite a motor nerve such as *n. ischiadicus* of the frog, and $f$ the frequency of the current, holds good for a large number of results. It applies, as Nernst has shown not only to motor but also to sensory nerves. If the mode of excitation of a nerve by the alternating magnetic field is similar to the mode of excitation of a nerve by the alternating electric current, we might reasonably expect the same law to hold for both phenomena. It is shown that such an expectation is not justified. Full details are given of the coil and strength of field used, together with complete data (in both tabular and graphical form) of the observed results. A. E. G.

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1907. *Rate of Solution of Hydrogen by Palladium.* **A. Holt.** (Roy. Soc., Proc. Ser. A. 90. pp. 226–237, May 1, 1914.)—The rate of solution of hydrogen by palladium is not a simple function of the concentration of gas in the metal. The rate curves consist of two portions (except in the case of palladium black), which are interpreted as referring to solution in two different forms of the metals. The smooth rate curve for palladium black is taken to mean the almost complete absence of one of these forms. T. M. L.

1908. *Crystalline Structure of Copper.* **W. L. Bragg.** (Phil. Mag. 28. pp. 355–360, Sept., 1914.)—It was found possible, by treating with acid the prepared faces of a natural crystal of copper to obtain crystal faces which could be used as reflectors in the X-ray spectrometer. When the crystal was placed in nitric acid until the surface was eaten away to an extent of perhaps ¼ mm., the faces were etched deeply into numerous parallel facets, which all reflected the light simultaneously in the usual way. This suggested that, internally, the crystal structure was perfect, and showed further that in some cases the whole specimen was composed of a single crystal. This method of obtaining a crystal surface was suggested by some previous experiments on zincite. The results of the investigations show that in a copper crystal the atoms are arranged on face-centred cubic lattice. This is the close-packed lattice to which attention has been drawn by Pope and Barlow. The crystal structure is the most simple of any as yet analysed. A. W.

1909. *Radio-active Elements.* **F. H. Loring.** (Chem. News, 109. pp. 241–242, May 22, 1914.)—It seems probable that the radio-elements are made up of associated atoms differing in atomic weight, and that these are exactly whole numbers taken from a Rydberg atomic weight series. The branching in the thorium series at ThC suggests the possibility that at this point the associates virtually part company, and that the respective end products may be considered as consisting of homogeneous whole-number atomic-weight atoms, standing in proportionate numbers to each other in the same ratio as the products ThD and $ThC_2$, namely 5 : 9. Then thorium itself should be a mixture $(ThII\ 235)_5 + (ThI\ 231)_9$. The mean value is 232·428, which is in agreement with the present accepted value for thorium, 232·42. The author arranges the radio-active elements in a table based on this principle, which indicates that the emanations of actinium and radium are possibly homogeneous, the former consisting entirely of atoms of atomic weight 223, and the latter 219. E. E. F.

1910. *Interatomic Forces and Chemical Affinity.* **J. J. Thomson.** (Phil. Mag. 27. pp. 757–788, May, 1914.)—Even in and around neutral atoms, if consisting of electrons and positive electricity, there will be a field of force varying with the electrical distribution within the atoms, and methods of representation have been developed by Sutherland, Einstein, and Kleeman. Only when every atomic molecule is neutral can the forces exerted by the molecule be represented as the resultant of forces due entirely to doublets within the atoms. In molecules containing oppositely charged atoms, doublets with poles on different atoms will also come into play. Chemical compounds should therefore fall into two classes accordingly, possessing strikingly different properties, for the separation of the poles, and corresponding increase in the movements, of doublets lying on two atoms should give rise to increased intermolecular forces, corresponding to higher intrinsic pressure, surface tension, and dissociating powers. The author quotes evidence from his *Rays of Positive Electricity* suggesting the existence of substances consisting of neutral atoms, *e.g.* CO, and also that such atoms, when combined with suitable atoms, may draw a negative charge from them, thus by *intra-molecular ionisation* giving rise to oppositely charged atoms. The setting of doublets in the electric field will increase the specific inductive capacity, and, involving molecular rotations, will diminish response to light vibrations, so that in compounds containing charged atoms high specific inductive capacity is to be expected with refractive indices less than accord with Maxwell's law. This is confirmed by Bädeker's observations [Abstract No. 1111 (1901)], and, as here shown mathematically, the abnormal specific inductive capacity should decrease with increasing temperature, which Bädeker's results confirm. These considerations also account for the exceptional powers of alcohol and water, shown by Bädeker to have abnormally high specific inductive capacity, to attract and bind corpuscles and so diminish mobility of negative ions in gases. Taking the relation $K = n^2$ as criterion of absence of inter-molecular ionisation, some typical gases fall into the two classes of the accompanying table; I, Neutral Atoms; II, Charged Atoms.

I. $H_2$, $O_2$, $N_2$, He, $Cl_2$, CO, $CO_2$, $CS_2$, $CCl_4$, $C_6H_6$, $CH_4$, $N_2O$.
II. $H_2O$, $NH_3$, $SO_2$, HCl, $CH_3OH$, $C_2H_5OH$, $CH_3Cl$, $CHCl_3$ (slight).

The effect on K of varied orientation in the doublets forming constituents of chemical compounds is considered, and illustrated by graphic formulæ of existing compounds, also the effect of varying the proportions of charged and uncharged molecules, and it is suggested that OH acting as an acid is of type $\overset{-}{O} - \overset{+}{H}$, and of type $\overset{=}{O} - H$ when basic.

The aid afforded to intra-molecular ionisation by the presence of extraneous charged atoms is very simply shown. Simple enumeration of the conditions for intra-molecular ionisation shows that it will occur only in a certain type of molecule, and only molecules with certain properties can produce it. Consideration of the chemical effects of the electric fields arising from intramolecular ionisation points to the existence of the *molecular compounds* which chemists have recently been disposed to throw doubt upon. Conduction in gases affords evidence of condensation of the gas around molecular doublets, ascribable to their strong electric fields. It is true that ordinary ionisation of a gas does not appear to accelerate chemical action, but this is explained by the small proportion of gas affected. In regions of intense ionisation, *e.g.* in the negative glow in a discharge tube, all kinds of chemical action seem to go on with great facility.

Considering the possibility of an active molecule, viz. one of exceptionally large electrostatic moment, holding one or more molecules of a different kind in combination, thermodynamic considerations lead to the conclusion that the permanent existence, at ordinary temperature, of such compounds will probably be possible only for a limited number of types of molecules. The addition of further attached molecules will render the resulting compound increasingly unstable, so that there will be a definite limit to the number of molecules that can be so bound, *e.g.* the number of molecules of water of crystallisation is never large. Liquids whose molecules have large electric moments may be expected to produce great ionisation when electrolytes are dissolved in them, as is confirmed by Walden [Abstract No. 806 (1906)]. Electrification by bubbling is to be expected only in case of compounds containing charged atoms, and this agrees with Bloch's experiments [Ann. Chim. Phys. 23. p. 28, 1911]. Investigation of valency and of the conditions for the existence of a chemical compound leads to a modification of Abegg's theory of positive and negative valency, differing from it in that while the atom can exert either valency it cannot bring both into play at the same time. The existence of unsaturated compounds does not constitute any difficulty, the question being why other analogues do not exist, and it is suggested that this may find its solution in the effect of the strong electric field in the neighbourhood even of a saturated atom restricting the freedom of motion of the corpuscles in neighbouring atoms.

G. W. DE T.

1911. *The Allotropy of Zinc.* **E. Cohen and W. D. Helderman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 23. pp. 59–60, July 3, 1914.)—In an earlier paper the authors have pointed out the possibility of the metals atomised by the Schoop process existing in several allotropic forms [Abstract No. 992 (1914)]. Dilatometric experiments carried out on a large quantity of zinc atomised by the Schoop process show that a marked contraction takes place after a very few hours at the ordinary temperature. Tests carried out on zinc oxide showed that the contraction could not be attributed to reaction between the paraffin used in the dilatometer and any zinc oxide which may possibly exist in the atomised zinc. F. C. A. H. L.

1912. *Formation of Neumann Lines.* **Matweieff.** (Rev. de Métallurgie, 11. pp. 766–770, July, 1914.)—In examining half-rolled samples of very soft steel with the naked eye after carefully polishing, the author has often observed straight lines which recall Neumann lines. This opinion was confirmed by H. le Chatelier after examining a number of photomicrographs submitted to him. Le Chatelier suggested that the lines were produced by the friction of the emery in those grains in which the cleavage planes were parallel to direction of rubbing. The lines are interrupted where they traverse grains of different orientation, but reappear further on in grains which probably form branches of the same dendrite. On the advice of le Chatelier experiments were carried out to prove that the grains in which the lines ran in the same direction possessed the same orientation. By progressive etching in 2% nitric acid in a mixture of equal parts of ethyl and amyl alcohols this was found to be the case. The results appear to indicate that the Neumann lines indicate the orientation of the grains and the direction of corrosion. The orientation of the Neumann lines in each grain form Widmanstätten figures: Neumann lines are in relief on the surrounding metal.

F. C. A. H. L.

1913. *Microscopic Study of Electrolytic Iron.* **O. W. Storey.** (Amer. Electrochem. Soc., Trans. 25. pp. 489–527, 1914.)—By double electrolytic refining of American ingot iron in an electrolyte of iron sulphate and ammonium chloride, using a current of 10 amps. per sq. ft. it is possible to get a material containing 99·971% Fe, the main impurities being hydrogen, carbon, and silicon. The crystals are propagated in a plane perpendicular to the surface of the kathode and gradually increase in size as they get further away from the sheet. As deposited, electrolytic iron is brittle and dissolves in acids more rapidly than zinc. This is probably due to the presence of occluded hydrogen since after heating to about 600° C., when a rapid evolution of hydrogen takes place, the metal becomes ductile and is much more slowly attacked by acids. No change is effected in the microstructure by heating at temperatures below the A3 range. Above A3, however, a change in the microstructure is effected, the rate of the change depending on the fineness of the deposit. A short heating converts the fine deposit into the typical structure of ordinary ferrite, while a coarse deposit becomes coarse-grained. These coarse grains can be refined by heating to 1000° C., or by prolonged annealing at the *Ac*3 point. No appreciable growth takes place at 1150° C. Prolonged etching of fused electrolytic iron revealed coarse grains each of which contained an inner grain structure. The boundaries of the coarse grains are V-shaped grooves, while those of the inner grains are shallow depressions. These inner grains are only destroyed by several annealings above the *Ac*3 point. The large grains are probably the gamma grains which split up during cooling into a large number of similarly oriented non-gamma nuclei forming the inner grain structure. F. C. A. H. L.

1914. *Velocity of Transformation of Steel on Heating and the Specific Resistance of Iron.* **A. Portevin.** (Comptes Rendus, 159. pp. 51–58, July 6, 1914.)—On quenching steel the electrical resistance is increased owing to the retention of a certain amount of carbon in solution. The amount retained can be calculated from Benedicks' formula $\Delta p$ — 26·8 C., where $\Delta p$ represents the increase in the resistance. Since the amount of carbon passing into solution at any predetermined temperature is a function of the time for which the steel is heated at this temperature, assuming constant rates of cooling, the velocity of the transformation at any particular temperature can be determined by observing the resistance of specimens quenched under identical conditions after being kept at the temperature for varying periods of time. This has been done for steels containing from 0·17 to 1·08 % carbon. The result shows that the solution of carbon on heating is far from being an instantaneous process. The increase in resistance of a 0·88 % carbon steel after heating to 750° C. for 2 minutes and quenching was 8·28 microhms-cm. while after 10 minutes at the same temperature the increase was found to be 18·28 microhms-cm. For this steel the state of equilibrium does not appear to be attained after 10 minutes at 750°, since after 10 minutes at 900° the increase was 20·06 microhms-cm. It is only fair to add that the increase in the quenching temperature facilitates the retention of the carbon in solid solution. Increase in the temperature or in the duration of the heating increases the resistance either by modifying the final state of equilibrium or by affecting the velocity of the reaction. By extrapolation from a series of results obtained with hypoeutectoid steels quenched in water after heating to 1000° C. for 10 minutes the author has obtained the value 9·8 microhms-cm. for the specific resistance of pure iron. This value closely agrees with the figures obtained by a number of workers, but differs considerably from the 7·6 value obtained by Benedicks.

F. C. A. H. L.

1915. *Changes in Mild Steel during Annealing.* **A. Stadeler.** (Ferrum, 11. pp. 271–276, June 8, 1914.)—A Siemens-Martin mild steel whose average composition was C, 0·10 % ; Mn, 0·45 % ; P, 0·026 % ; and S, 0·048 % was rolled into plates 15·5 mm. in thickness. Complete homogeneity was proved by making numerous analyses, impact tests and micrographic examinations. This material was then annealed in a coal-fired furnace at the usual temperatures adopted in practice for the annealing of plates, viz. 860° C., the max. temperature never being allowed to rise above 900°. After periods of annealing varying from 1½ to 600 hours the samples were cooled slowly and examined for variations in thickness, resilience, and microstructures. In spite of the fact that the atmosphere of the furnace always contained an excess of CO, a certain amount of scaling took place, the plates losing about 12·8 % in thickness during 600 days. After 15 days the material was practically decarbonised: the manganese and phosphorus remained constant over the whole period, while the sulphur remained constant for 8 days and then slowly increased. Resilience increased during the first 1½ hours' heating; it then fell somewhat and after 14 days began to increase again. Grain growth, as revealed by microstructure, was more rapid and greater on the outside than in the middle of the specimen. This is undoubtedly to be ascribed to the cold working on the outside of the plates. For material of the same composition the resilience decreases as the grain size increases, but, naturally, as the carbon becomes oxidised away the resilience increases accordingly. After internal stresses have been removed, the grain growth becomes a function of the time. F. C. A. H. L.

**1916.** *Effect of Carbon, Silicon, Cobalt, and Copper on the γ-δ Transformation of Pure Iron.* **R. Ruer** and **R. Klesper**. (Ferrum, 11. pp. 257–261, June 8, 1914.)—Earlier researches on the Fe-Co and the Fe-Cu systems have indicated that in addition to the three well-known allotropes of iron there exists a fourth (δ) modification, which is stable above 1400° C. A cooling curve of electrolytic iron containing 99·96 % Fe showed that solidification occurred at 1528° C., and that there was a well-marked evolution of heat at 1401°. Addition of carbon rapidly raises the temperature of this change, lowers its intensity, and at the same time increases the tendency towards undercooling. At 0·1 % carbon the temperature of the change becomes constant at 1487°, and the horizontal line joins the liquidus at 0·4 % carbon. Silicon decreases the temperature of the change, at first slowly and then more rapidly as the content of Si increases: 1·2 % Si lowers the temperature to 1385°. Cobalt raises the critical point to 1492° at a concentration of 18 %; the temperature of the change then remains constant up to a concentration of 25 %, at which it becomes coincident with the solidification point. Copper behaves in an exactly similar manner, 6·5 % raising the critical point to 1475° C. At this point it becomes constant and joins the liquidus at a concentration of 18 % copper. The authors consider that this research conclusively proves the existence of the δ modification of iron, and that it will serve as a basis of explanation of discrepancies in the results of various workers on the changes occurring in iron at high temperatures.

F. C. A. H. L.

**1917.** *Hardness and Electrical Resistance of Iron-Carbon Alloys.* **R. Vondráček**. (Int. Zeitschr. Metallog. 6. pp. 172–182, May, 1914.)—The theory of Andrew [Abstract No. 1351 (1914)] to the effect that the extraordinary hardness of martensite is due to the existence of exceedingly finely divided cementite embedded in a ground mass consisting of austenite containing a little ferrite is not in agreement with the laws laid down by Kurnakow and Žemcžužny, who have shown that the hardness of a mixture is the arithmetic mean of the hardnesses of its constituents. Now the researches of Maurer have shown that the hardness of carbon-rich austenite is not appreciably greater than that of ferrite, so that the hardness of martensite as defined by Andrew should be very little greater than that of pearlite. Conductivity measurements of quenched steels show that practically the whole of the carbon exists in a state of solution.

The author considers that hardness is a function of the transformation, owing to the α-iron not being able to assume its proper orientation. The quenched metal, therefore, has an open, non-oriented structure, which accounts for the lowering of the density and the increase of the hardness. In this form the theory is similar to the amorphous theory as applied to cold-worked metals. From a detailed consideration of the results of le Chatelier, Gumlich, and Benedicks on the resistance of iron-carbon alloys the author concludes that the specific resistance of cementite is about 38·5 microhms-cm., and that the ferrite in hypereutectoid steels has an appreciable carbon-content which increases as the total carbon increases. It is also concluded that the eutectoid ferrite contains from 0·06–0·07 % carbon at the eutectoid temperature, and that this content increases with falling temperature until it attains a maximum of 0·14 % at 600° C. F. C. A. H. L.

1918. *Structure, Faculty of Recrystallisation, and Resistance of Electrolytic Copper.* **O. Faust.** (Zeitschr. anorg. Chem. 78. pp. 201–212, 1912. Rev. de Métallurgie, 11. pp. 390–394, June, 1914.)—Experiments have been made to determine if the electrodes affected the product during the electro-deposition of copper at ordinary temperatures. The electrodes used were iron, coarsely crystalline white iron, bismuth and antimony, wood charcoal and gas carbon. The structure of the copper appears to be independent of the material of the kathode, and there is no correlation between the crystals of the electrode and those of the deposit. The current density and the concentration of the copper ions, however, exercise a considerable influence. The results obtained were purely qualitative, but show that the size of the crystals decreases with increase of current density and with decrease of ionic concentration. This accounts for the small crystals obtained in the technical method of depositing copper. With low current-density the copper deposited is ductile, while with high density the deposit is brittle. Microscopic examination shows that the structure of electro-deposited copper consists of crystals having a parallel orientation. Annealing causes a considerable increase in growth, but the crystals still retain their parallel orientation. The ultimate size of the crystals is practically the same as that attained in the case of deformed cast copper and does not appear to depend on the method of production. Apart from bismuth and antimony, the difficulty in the way of studying the vectorial properties of metals lies in the trouble experienced in obtaining crystals of sufficient size. On account of the parallel orientation of the crystals, electro-deposited metals appear to be suitable for this study, and the author has therefore determined the lower elastic limit of electro-deposited copper in directions parallel to and at right angles to the direction of growth of the crystals, by the method of Faust and Tammann. The values obtained were 667 kg./cm.$^2$ and 680 kg./cm.$^2$ respectively. Slowly cooled cast copper shows a value of 205 kg./cm.$^2$. The difference may be ascribed to the presence of cuprous oxide in the cast copper and to the presence of occluded hydrogen in the electrolytic product. After annealing *in vacuo* for 1 hour at 1000° C. the lower elastic limit of the electrolytic copper fell to 205 kg./cm.$^2$, but this decrease is to be ascribed to structural changes rather than the removal of impurities. In electrolytic copper the gliding planes produced by straining are not wholly normal to the direction of the crystal growth, but are always visible in two directions. These two directions may appear at the same time in the same crystal, are always equally inclined to the direction of the current, and are found on almost every surface of the sample. The surface in contact with the electrode shows smaller crystals than the surface which was in contact with the electrolyte. Annealing does not alter the direction in which gliding planes are produced after straining. F. C. A. H. L.

1919. *Copper in Steel: Influence on Corrosion.* **D. M. Buck.** (Journ. Indust. and Engin. Chemistry, 5. pp. 447–452, 1913.)—The steels used were two basic open-hearth steels, containing respectively; C, 0·10; Mn, 0·34; S, 0·034; P, 0·019; and C, 0·13; Mn, 0·45; S, 0·036; P, 0·042; and one Bessemer steel containing C, 0·08; Mn, 0·46; S, 0·070; P, 0·092. The amount of copper added was sufficient to give a copper content of either about 0·15 or 0·25 %. The steels with and without copper were put through the same mill operations, and were finally obtained as corrugated strips, which were tested for atmospheric corrosion at three different stations: (1) in the Pennsylvania Coke regions, where the air contains notable amounts of sulphurous and sulphuric acids, etc.; (2) on the sea coast; (3) in the country. The strips were put on open sheds and exposed to the atmosphere on all sides, the time of the test lasting for several months; observations were made from time to time. Full details are given with respect to each test-piece. As a general result it may be considered as proved that copper has a very beneficial effect in retarding corrosion; the copper-containing steels resist the atmosphere from one and a-half to two times as well as normal steels without copper, and there is little or no difference in the average between a copper content of 0·15 and 0·30. Accelerated acid tests gave similar results but it should be pointed out that in some cases the results of the acid tests are directly opposite to the results of the atmospheric tests. T. S. P.

1920. *Positive Ions from Non-metallic Elements.* I. *Precipitation of Metals from Solutions of their Salts by Yellow Phosphorus.* **R. M. Bird** and **S. H. Diggs.** (Amer. Chem. Soc., Journ. 36. pp. 1382–1392, July, 1914.)—The principal products of the action of yellow phosphorus on solutions of copper sulphate are copper and phosphoric acid, which are accompanied by small proportions of (1) copper phosphide, which results from the action of the precipitated copper on the phosphorus, and (2) phosphorous acid, which is due to the interaction of the phosphorus and the phosphoric acid originally formed. The quantitative results obtained are in accordance with the equation, $5CuSO_4 + 2P + 8H_2O = 5Cu + 2H_3PO_4 + 5H_2SO_4 + 2H_2O$, and since the copper is formed only on the surface either of the phosphorus or of a conductor connected with the phosphorus, the action appears to be electrolytic in character and to be represented by the equations, $5Cu^{++} + 2P = 5Cu + 2P^{+++++}$ and $2P^{+++++} + 10OH^{-} = 2P(OH)_5 = 2H_3PO_4 + 2H_2O$. This conclusion is corroborated by the observation that, in a cell consisting of a copper electrode immersed in 0·5N copper sulphate solution and a phosphorus electrode immersed in dilute sulphuric acid, the phosphorus is always negative to the copper, the e.m.f. of the cell being about 0·85 volt; little difference on the resulting current is made by varying the concentration of the sulphuric acid or by replacing the latter by distilled water, or a solution of magnesium sulphate or zinc sulphate or one from which the copper has been precipitated by phosphorus.

The conclusion is drawn that, in displacing certain metals from their salts, phosphorus first passes into solution as a positively charged ion, in the same way as do the metallic elements, the chief distinction between the so-called non-metallic and the metallic elements depending upon the tendency of the former to hydrolysis and the subsequent ionisation of the hydrolytic product, rather than upon the ability to form positive ions. Experiments are being conducted to ascertain if this property of phosphorus is general with non-metallic elements. T. H. P.

1921. *Electrical Conductivity of Bromine Solutions of Iodine.* **W. A. Plotnikow** and **V. E. Rokotjan.** (Russian Physico-Chem. Soc., Journ. 45. pp. 193–199, 1913.)—The authors have measured the conductivities of solutions of iodine in bromine with concentrations of 0–44·5 % I (or 72·28 % of BrI) at 25°, and of 44·5–59·48 % I at 40·6°. The specific conductivity at 25° increases continuously from $\chi_{25} \times 10^6 = 0{\cdot}32$ for 12 % of I to 126 for 44·5 % of I. The molecular conductivity diminishes uninterruptedly with increase of dilution. With rise of temperature the conductivity increases, the extent of the change being greater for dilute than for concentrated solutions. These results are explained by the formation of an iodine bromide and its dissociation into bromine and iodine ions. The marked electrical conductivity of bromine solutions of iodine does not agree with the view that conductivity is conditioned by appreciable increase in the dielectric constant of the solvent. Comparison of conducting solutions of iodine in bromine with non-conducting solutions of potassium bromide in bromine indicates the invalidity of the hypothesis which regards electrolytes as divisible into "good" or "typical," such as potassium bromide, and "bad." Electrical conductivity must, indeed, be considered as a consequence of the electrochemical relations of the solute with the solvent. T. H. P.

1922. *Influence of the Current Frequency and Temperature on the Yield of Ozone.* **N. Puschin** and **M. Kauchtschev.** (Russian Physico-Chem. Soc., Journ. 46. pp. 576–590, 1914.)—With constant periodicity up to 800 per sec., the yield of ozone increases with increase of the voltage from 6500 to 8000. When the frequency is varied, but the voltage and other conditions kept constant, the yield of ozone increases as the frequency is increased to 1240 ∿ per sec. at 6500 volts, to 950 at 7000 volts, and to 660 at 8000 volts; if the rate at which the air passes through the ozoniser remains the same, increase of the frequency beyond these limits is accompanied by diminution of the yield of ozone. Continued increase of the air current displaces the max. yield towards continually increasing frequencies. Rise of temperature from 0° to 28° causes the yield of ozone to increase, but further rise diminishes it. T. H. P.

1923. *Theory of the Rotatory Power of Liquids.* **A. Mazzucchelli.** (Gazzetta Soc. Chim. Ital. 44. 1. pp. 410–417, 1914.)—According to van't Hoff's theory and to Guye's results, the rotatory power of a substance depends on the degree of asymmetry of the molecule, but since this varies with the orientation of the molecule, it would seem that the observed rotatory power represents the mean of a number of values differing more or less among themselves. If, therefore, the molecules can be constrained wholly or partly to assume a definite orientation, the optical activity should be changed. With the liquid crystals examined by Vorländer [Ber. Deut. Chem. Gesell. 41. p. 2033, 1908], the great superiority of the rotations over those exhibited by the same compounds in solution renders it probable that the liquid crystal consists of an asymmetric aggregate of many simple molecules. That liquid crystals are highly polymerised is, indeed, indicated by their relatively slight solubility.

In the case of an electrolyte, the charges of the ions are regarded as localised at certain points occupying invariable positions in the molecule. If the electrolyte is optically active, the action of a current passing in the direction of the ray of polarised light constitutes a force applied only at one portion of the molecule, and should hence tend to orientate the latter in a definite direction. Any variation in the rotation would depend solely on the direction, and not on the sense, of the electric field, since, according to Helmholtz's principle of reciprocity, all modifications produced in a ray of light in its passage through any medium are independent of the direction of that passage. Experiments made with solutions of potassium uranylmalate showed, however, that the passage of a current is accompanied by no appreciable alteration in the rotation. The author draws the conclusion, which is confirmed by calculation, that the directive force of the current is very small in comparison with the active forces exerted between the molecules.

T. H. P.

1924. *Analysis of very Small Quantities of Gas; Application to the Analysis of Air.* **P. A. Guye** and **F. E. E. Germann.** (Comptes Rendus, 159. pp. 154-157, July 18, 1914.)—An apparatus is described by means of which quantities of gas of the order of a few cubic millimetres may be accurately analysed. It is hoped to increase the sensitiveness of the method to such an extent that 1-2 c.cm. of air will suffice for a series of estimations, a result which would be of great importance in connection with the chemical investigation of the atmosphere at high altitudes. [*Errata.* Ibid. p. 292, July 20, 1914.]

T. S. P.

1925. *Compressibilities of Solutions of Inorganic Salts.* **W. Watson.** (Roy. Soc. Edinburgh, Proc. 33. pp. 282-291, 1912-1913.)—With a view to testing whether the formula from which Tammann calculates the internal pressures is satisfied at high pressures, the author has measured the densities and compressibilities of twenty-one solutions of normal concentration or under; a series for water being also taken. Some of the results obtained by Tammann (from expansibility) are compared with some of the author's results from compressibility, and good agreement is shown. The question of relative molecular depression of the freezing-point is also briefly discussed.

L. H. W.

1926. *Work done in Formation of a Surface Transition Layer of a Liquid Mixture.* **R. D. Kleeman.** (Cambridge Phil. Soc., Proc. 17. No. 5. pp. 409-413, May, 1914.)—The expression obtained [see Abstract No. 843 (1913)] from surface tension considerations is here applied to mixtures of certain liquids.

L. H. W.

1927. *Thermodynamic Potential as a Kinetic Quantity.* **H. Hulshof.** (Konink. Akad. Wetensch. Amsterdam, Proc. 23. pp. 85-91, July 13, 1914.)—Mathematical.

T. H. P.

1928. *The Ideal Diffusion Coefficient and a Fundamental Law concerning the Diffusion of Dissolved Substances.* **G. McP. Smith.** (Amer. Chem. Soc., Journ. 36. pp. 847-864, May, 1914.)—The diffusion coefficient D is derived from the formula $dS = -Dq \, . \, dc/dx \, . \, dt$, in which $dS$ is the quantity of the dissolved substance which passes at the point $x$ in the time $dt$ through the cross-section $q$ of a diffusion cylinder under the influence of the concentration fall $dc/dx$. The value of D depends upon the temperature and upon the actual concentration. The author proposes to describe as the *ideal diffusion coefficient*, I, the ratio D/M of the ordinary diffusion-coefficient to the molecular weight, and states that this coefficient indicates the number of mols. of a compound which in the unit cross-section would pass in unit time through the unit molal concentration-interval with unit velocity.

Values plotted for a series of compounds show a linear relation between M and log I, so that for many substances

$$M = (K/D)^{1/n-1}.$$

Thus for a series of solids diffusing in water $n = 1{\cdot}4894$, and $K = 6{\cdot}66$. For gases in water $n = 1{\cdot}5826$ and K = about 10. For metals in mercury $n = 1{\cdot}4588$, $K = 13{\cdot}9$. This equation appears to represent a fundamental law of diffusion. Since $n$ does not differ much from 1·5 it leads approximately to Exner's rule that $DM^{1/2} = \text{const.}$ T. M. L.

1929. *Negative Osmose.* **F. E. Bartell.** (Amer. Chem. Soc., Journ. 36. pp. 646–656, April, 1914.)—Salt solutions of sulphates, chlorides, nitrates, and acetates were placed in osmotic cells constructed of porcelain of the same degree of porosity. Whilst some of the solutions gave positive osmose, others gave negative osmose, *i.e.* the direction of flow was from the concentrated to the more dilute solution. The flow of the solution as a whole through the membrane, in the experiments with nitrates and chlorides, was toward the more dilute solution, when the anion had a greater migration velocity than the kathion; the rate of flow increased with the difference between the migration velocities of anion and kathion. The appearance of negative osmose is dependent on the pore diameter of the membrane. Negative osmose of $MgCl_2$ predominates only when the pore diameters are somewhat less than 0·4 $\mu$. Negative osmose appears to depend on electrical polarisation of the capillaries brought about through ionic adsorption by the membrane. T. M. L.

1930. *Absolute Measurement of Coefficients of Adsorption.* **J. Bancelin.** (Comptes Rendus, 158. pp. 791–792, March 16, 1914.)—Measurements were made of the adsorption of substances on glass surfaces of known area. The quantities of a colouring-matter adsorbed were $2 \times 10^{-8}$ and $14 \times 10^{-8}$ grains per sq. cm. when the concentrations were $10^{-6}$ and $10^{-6}$ gm. per c.cm. respectively. In the case of common salt, the adsorption was $14 \times 10^{-8}$ gm. per sq. cm. at a concentration of N/10,000. Other salts gave analogous results. T. M. L.

1931. *Molecular Magnitude and Electrical Conductivity of some Fused Salts.* **P. Walden.** (Acad. Sci. St. Pétersbourg, Bull. 6. pp. 405–422, April 1, 1914.)—A series was selected of organic salts which melt at very low temperatures and could therefore be studied by the methods used already for aqueous and non-aqueous solutions. Four substituted ammonium nitrates gave at 100° C. association-factors ranging from 4 to 9; three other fused salts resembled water in giving values approaching 2. The surface tension of the fused salts was high, the lowest of six values being about one-half that of water. All the salts were at least 10 times more viscous than water, but two bromides were over 140 times more viscous. The electrical conductivity of five salts increased according to a linear law with rise of temperature, the molecular conductivity being greatest when the viscosity was least, and the temperature coefficient being greatest when the viscosity was greatest. The organic salts at low temperatures behave just like the simple inorganic salts at high temperatures. In view of the associated character of the salts there can be no question of dissociation into simple ions, but the fused salts may well contain complex ions as in the case of aqueous and other electrolytic solutions.

T. M. L.

1932. *Dissociation of Hydrogen into Atoms.* Part I. *Experimental.* **I. Langmuir** and **G. M. J. Mackay.** (Amer. Chem. Soc., Journ. 36. pp. 1708–1722, Aug., 1914.)—Earlier experiments on the convection of heat from wires of different kinds in various gases [see Abstracts Nos. 887A, 827B (1912)] led to a general theory of convection from hot bodies which renders possible the approximate calculation of heat losses from a wire at any temperature in any gas which behaves normally. The fact that at high temperatures the observed heat loss in hydrogen increases rapidly until it greatly exceeds the calculated value led to the suggestion that the hydrogen is partly dissociated into atoms at these temperatures. Application of a development of the theory of heat conduction in a dissociating gas indicated that at atmospheric pressure this dissociation amounts to 1·2 % at 2300°, 44 % at 3100 and 84 % at 3500° K, the heat of formation of the molecules from the atoms being given as 130,000 cals. per 2 gm. of hydrogen; this result conflicts seriously with the measurements of the specific heat of hydrogen by the explosion method. In addition to this qualitative evidence of the dissociation of hydrogen there is a large amount of chemical evidence proving indubitably that when hydrogen at low pressures comes into contact with a heated metallic wire, the gas is chemically activated, and that it can, under suitable conditions, retain its activity for several days. But as there is good reason to suspect that the actual values for the degree of dissociation previously given are considerably too high, probably owing to an incorrect assumption concerning the diffusion coefficient of hydrogen atoms through molecular hydrogen, two methods independent of such assumption have now been employed to obtain more or less quantitative data on the dissociation.

The first of these is based on measurements of the total heat losses from tungsten wires at a series of different pressures, ranging from 10 mm. to atmospheric pressure. The results show that, even at the lowest pressure employed, the temperature coefficient of $W_D$—that part of the heat loss dependent on the dissociation of the gas—is practically as great as at atmospheric pressure, so that even at these low pressures the hydrogen around the wire is not nearly completely dissociated; these experiments give, however, an upper limit to the degree of dissociation.

In the second method similar measurements were made at very much lower pressures, varying from 0·01 to 0·2 mm. At the lowest pressures the molecules travel in straight lines directly from filament to bulb, and the hydrogen atoms produced practically never return to the filament without having struck the bulb many times and having had ample opportunity to recombine. If, by heating the filament to very high temperatures, a condition could be reached such that every hydrogen molecule striking the filament becomes dissociated, these measurements would lead to a direct determination of the heat of formation of hydrogen molecules; in the absence of definite evidence that the dissociation is complete, the method gives at least a lower limit for the heat of formation.

Experiments made with nitrogen and with hydrogen show a very striking difference between the effects in the two cases. In nitrogen the values of the power consumption decrease steadily as the pressure is reduced, and the same is the case, at the lower temperatures, in hydrogen; but in the latter gas at higher temperatures the power consumption is considerably greater at lower pressures than at atmospheric pressure. At very high temperatures the value of $W_D$ for hydrogen increases very rapidly and becomes 50 or 100 times as large as the possible experimental error. T. H. P.

1933. *Transference Number, Conductance, and Ionisation of Hydriodic Acid at 25°.* **E. K. Strachan** and **V. G. Chu.** (Amer. Chem. Soc., Journ. 36. pp. 810–819, May, 1914.)—Since the transport-numbers of the ions may vary with concentration, it is impossible to calculate the ionisation accurately from the conductivities in the ordinary way. Better results will be given by the formula, $\gamma = \Lambda/\Lambda_0 . T . \eta/\eta_0$, where T is the transport-number and $\eta$ the viscosity. Direct experiments with hydriodic acid showed that the transference-number for the kathion is constant at 0·826 ± 0·001 from 0·2 to 0·06N. The viscosities were 0·9954 at 0·1968N, 0·9966 at 0·0984N. The conductance was measured from 0·2 to 0·001N. The formula given above would indicate only 97 % dissociation at extreme dilution; this might be due to a change in the transport-number, but is more probably due to faults in the measurements of conductance, arising especially from doubt as to the way in which the water-correction should be made. T. M. L.

1934. *Ionisation and the Law of Mass Action.* II. *Osmotic Data in Relation to Combined Water.* **W. R. Bousfield.** (Chem. Soc., Journ. 105. pp. 600–609, March, 1914.)—The gas-equation $PV = RT$ when applied to the osmotic pressure of cane sugar at 20° gives values of R which rise by 20 % in the range of concentrations from N/10 to N and reach a value 87 % greater than the gas-constant. The "weight-normal" equation, which may be written $Phe/1000 = RT$($h$ = no. of mols. of water per mol. of solute, $e$ = mol. wt. of water) gives values which increase only by about 6 % from 0·3 N to N, and average only 6 % above the gas-constant. If, however, only the free water be considered, the equation becomes $P(h - n)e/1000 = RT$ or $P(h - n) = R'T$; if the combined water $n$ is assumed to be constant at 6 mols. per mol. of solute the value of R only varies 8 % between N/2 and N, and the mean of values, 0·0820, differs very little from the gas-constant 0·0821.

In the same way only the free water may be regarded in studying freezing-points. The equation then becomes $\Delta(h - n) = F'i$, where $i = 1$ for non-electrolytes and $F' = F1000/e$($F = 1{\cdot}855$ for water, $e = 18{\cdot}016$). Morse and Fraser discovered the relation $\Delta = 1{\cdot}85\ M\rho$, where $\rho$ is the density of the solution. If the two freezing-point equations be combined they give $n = h(1 - 1/\rho)$. The values of $n$ calculated by this equation from the freezing-point data agree satisfactorily with those calculated from the osmotic equation $P(h - n) = R'T$ on the assumption that $R'$ is constant and $n$ a variable.

A similar equation is given for the lowering of the vapour pressure, which the author expresses in a later paper by the equation $\delta p/p . (h - n) = i$, where $i = 1$ for non-electrolytes. The three equations may be combined in the form $P/R'T = \delta p/p = \Delta/F' = i/(h - n)$, where $F' = 103{\cdot}2$ and $R' = 4{\cdot}557$. T. M. L.

1935. *E.M.F. of Concentration Cells of Solutions of Sodium in Liquid Ammonia.* **C. A. Kraus.** (Amer. Chem. Soc., Journ. 36. pp. 864–877, May, 1914.)—From measurements of the electromotive force of concentration cells of solutions of sodium in liquid ammonia values have been calculated for the transference numbers at different concentrations. The ratio $(1-n)/n$ of the fraction of the current carried by the negative and positive ions approaches a limiting value of 7 in dilute solutions, and increases to 280 at a concentration somewhat less than normal. Assuming the speed of the positive ion to remain constant, the mean speed of the negative ion increases 40 times between about 0·001 and 1·0 normal. Assuming the equivalent conductance of the positive ion to be 180 (that of the sodium ion), the equivalent conductance of the dilute metal solution is calculated to be 1040. These results are accounted for on the assumption that the ions $Na^+$ and $e^-$ exist in solution. At high dilutions the negative electron $e^-$, which serves as negative ion, is surrounded by an envelope of ammonia which determines its speed. At higher concentrations some of the negative electrons are free from the ammonia envelope for a fraction of the time and move with a speed comparable with that of the negative electrons in metals. This accounts for the rapid increase of the transference number of the negative carrier at higher concentrations, for the number of free electrons increases as the proportion of metal to ammonia increases. The electrode phenomena already described are in accord with this hypothesis.

On the basis of the osmotic work involved, it is shown that in the most concentrated solutions a portion of the current is carried by carriers not associated with ordinary matter. T. M. L.

1936. *Potential of the Copper Electrode and Activity of Bivalent Ions.* **G. N. Lewis** and **W. N. Lacey.** (Amer. Chem. Soc., Journ. 36. pp. 804–810, May, 1914.)—The best obtainable value for the normal electrode potential of copper against cupric ion at 25° is $E^\circ = -0{\cdot}3469$ volt, a figure that is probably correct within 1 millivolt. The value deduced in the ordinary way is $E^\circ = -0{\cdot}3347$ volt, more than a centivolt lower. T. M. L.

1937. *Electrostenolysis.* **H. N. Holmes.** (Amer. Chem. Soc., Journ. 36. pp. 784–789, May, 1914.)—By electrostenolysis is meant the deposition of a metal or its oxide in very fine capillaries when the solution filling these capillaries is electrolysed. Frequently there is an evolution of gas from the deposit. Braun, who was one of the first to study this phenomenon, could only use glass capillaries: but deposits of metallic oxides and metals, due to electrostenolysis, are greatly increased by the use of capillary membranes in the form of glass tubes packed with such finely powdered substances as glass, sulphur, and silica. These tubes can be broken in sections and the contents examined very advantageously. In addition to the results obtained by Braun, electrostenolytic deposits were secured in aqueous solutions of cuprous bromide, cuprous iodide, copper sulphate, Fehling's solution, sodium plumbite, sodium stannite, ammonium molybdate, manganese chloride, and nickelous bromide. These results were secured with direct current at 110 volts, but a deposit was also secured in a solution of cobaltous bromide using alternating current. A discharge of bromide ion was observed around an initial deposit of cobalt peroxide formed by electrostenolysis. The effects are attributed to negative electrostatic charges which may accumulate till they are able to discharge the positive ions, depositing metal or oxide in the capillary. This then acts as a combined kathode and anode in the path of the current, and may grow to visible size if the current tends to deposit solid at both anode and kathode, or deposits more at the kathode than it dissolves at the anode.
T. M. L.